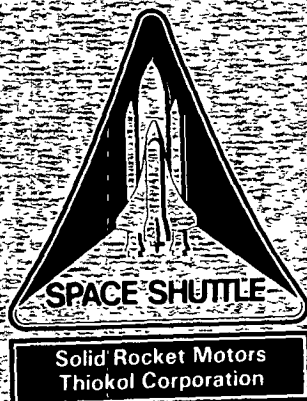


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TWR-50218



# Evaluation of EDR-3 Vibration, Shock, Temperature, and Humidity Recording Unit Final Test Report

July 1990

Contract No. NAS8-30490  
DR. No. 5-3  
WBS No. 48601-03-04  
ECS No. 3723

**Thiokol** CORPORATION  
SPACE OPERATIONS

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

Publications No. 90722

(NASA-CR-184006) EVALUATION OF EDR-3  
VIBRATION, SHOCK, TEMPERATURE, AND HUMIDITY  
RECORDING UNIT Final Report (Thiokol Corp.)  
79 p

CSCL 14B

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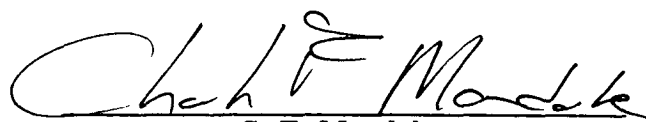


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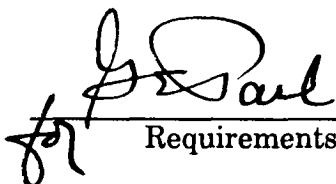
Evaluation of EDR-3 Vibration, Shock, Temperature,  
and Humidity Recording Unit  
Final Test Report

Prepared by:

  
K. G. Rees  
Design Engineer

  
C. F. Mondale  
Test Planning and Reports

Approved by:


 7-12-90  
Requirements Manager

 7/12/90  
System Safety

  
Program Manager

 12 July 90  
Reliability

  
Integration Engineer

 7/12/90  
Data Management/Release  
ECS No. 3723

## ABSTRACT

The purpose of this evaluation was to determine if the self-contained, off-the-shelf, EDR-3 manufactured by Instrument Sensor Technology could be qualified to monitor shock, vibration, and temperature during rail transportation of space shuttle solid rocket components.

The evaluation testing started in November 1989 and continued until June 1990. Two EDR-3 units were used to monitor both on- and off-plant shipments of shuttle components. In addition, extensive testing was performed at Thiokol's Vibration Test facility, T-53.

Testing demonstrated that the EDR-3 is capable of successfully monitoring actual shipments of solid rocket hardware. Thiokol metrology has verified the accuracy of temperature monitoring. In addition, calibrated shock/vibration testing demonstrated that the EDR-3 does accurately record acceleration.

It is recommended that the vendor modify the EDR-3 data recovery system to allow remote communication via a 30-foot cable. This would permit communication with the unit mounted on a case segment after a rail car cover is installed. The vendor will make this change and produce a new model, designated EDR-3-10. It is further recommended that Thiokol qualify the EDR-3-10 for transportation monitoring of RSRM components.

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## ABBREVIATIONS AND ACRONYMS

CEI	contract end item
DA	double amplitude
dB	decibel
EDR	Environmental Data Recorder (model)
ft	foot
g	gravity
Hz	hertz
IBM	International Business Machines
in.	inch
IST	Instrumented Sensor Technology
KSC	Kennedy Space Center
lb	pound
min	minutes
oct	octave
PSD	power spectral density
RAM	random access memory
RSRM	redesigned solid rocket motor
sec	second
sps	samples per second
SRM	solid rocket motor
TMU	transportation monitoring unit
V	volt
°F	degree Fahrenheit

1

## INTRODUCTION

This report documents the procedures, performance, and results obtained from evaluation testing of the Environmental Data Recorder Model No. 3 (EDR-3). The EDR-3 instrument is manufactured by Instrumented Sensor Technology (IST). This evaluation was conducted between November 1989 and June 1990. The purpose the testing was to determine if the EDR-3 could be qualified to monitor, both on-plant and off-plant, shipments of redesigned solid rocket motor (RSRM) components. This effort was in accordance with Program Directive No. 53 and Action Order 4B6-55. Testing was performed in accordance with ETP-0539A, Evaluation of EDR-3 Vibration, Shock, Temperature, and Humidity Recording Unit.

The majority of testing on the EDR-3 was conducted at Thiokol Test facility T-53 and Thiokol Metrology Lab. Other tests included monitoring actual shipments of RSRM components both on- and off-plant.

The testing was accomplished to identify if the EDR-3 system could be qualified for monitoring the RSRM rail shipments to Kennedy Space Center (KSC). The current system was not able to pass a qualification test and is being used only until a new system can be qualified.

### 1.1 TEST ARTICLE DESCRIPTION

The EDR-3 recording unit is battery powered and contains a triaxial accelerometer capable of monitoring longitudinal, vertical, and transverse axes. In addition, an internal temperature and humidity sensor are packaged within the unit.

The EDR-3 recording unit is enclosed within a 4.2 by 4.4 by 2.2-in. anodized aluminum housing. The EDR-3 recording unit weighs 2.2 lb. Recorded data is stored within the unit's internal main memory (static random access memory (RAM)). Recorded data are downloaded from the EDR-3 recording unit via a standard RS232 cable which can be connected to any IBM compatible computer. Software provided with the instrument is used to print data summary reports and to plot detailed shock/vibration and temperature/humidity data.

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## TEST OBJECTIVE

The test objective of ETP-0539A, Evaluation of EDR-3 Vibration, Shock, Temperature, and Humidity Recording Unit, is as follows:

The objective of this test was to evaluate the performance of the EDR-3 Environmental Shock and Vibration Sensor/Recorder in various transportation environments.

3

## EXECUTIVE SUMMARY

### 3.1 SUMMARY

This section contains an executive summary of the key results from test data evaluation. Additional information and details can be found in Section 6, Results and Discussion.

Testing to evaluate the EDR-3 for monitoring RSRM rail shipment to KSC was successful. The EDR-3 recorded shock, vibration, and temperature accurately over the intended temperature range. The EDR-3 was tested at -30°, 70°, and 140°F and functioned correctly within tolerances at each temperature range.

### 3.2 CONCLUSIONS

The following lists the conclusions as they relate specifically to the objective of Section 2.

#### Test Objective Summary

<u>Test Objective</u>	<u>Conclusions</u>
The objective of this test was to evaluate the performance of the EDR-3 Environmental Shock and Vibration Sensor/Recorder in various transportation environments.	<u>Successfully Evaluated.</u> The EDR-3 will operate accurately in the intended environment. The EDR-3 recorded shock, vibration, and temperature within the specified tolerances from -30° to 140°F.  Results indicate that the EDR-3 can be qualified and used to monitor transportation of solid rocket motor (SRM) components. If qualified, it will meet the transportation monitoring requirements specified in CEI CPW1-3600A, paragraph 3.2.8.b, and CDW2-3847.

### 3.3 RECOMMENDATIONS

It is recommended that the EDR-3 be modified to enable remote communication via a 30-ft data cable (i.e., communication with the unit while under a rail car cover). The new model will be designated as the EDR-3-10. It is further recommended that the EDR-3-10 be qualified for transportation monitoring of RSRM components by Thiokol. This would enable the EDR-3-10 to replace the current rail transportation monitoring unit as well as enable its use for any future monitoring requirements (i.e., on-plant transportation).

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## INSTRUMENTATION

All reference, control, and response instruments used to evaluate the EDR-3 recording unit were provided by Thiokol's Metrology Laboratory and Thiokol's Vibration Test facility, T-53. These instruments met the system requirements of MIL-STD-45662.

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## PHOTOGRAPHY

Photographs of the test setup at T-53 and other demonstrations of the EDR-3 recording unit are included in this report. These photographs can be obtained from the Photograph Lab using the following film serial numbers: 114647, 117511, 117422, and 117463.

6

## RESULTS AND DISCUSSION

During the evaluation testing, the EDR-3 was found to have the following characteristics.

- a. The EDR-3 can be operated without excessive training.
- b. The recorded data can be downloaded from the instrument and reduced by field technicians, and the data are presented in a manor which is easily understood. The instrument is capable of recording complete shock and vibration wave forms. The software has the ability to plot the data in an acceleration versus time history format.
- c. The power supply can survive the intended environment and will continuously record for 17 days.
- d. The EDR-3 will not introduce an unacceptable hazard to Thiokol personnel or hardware.
- e. The EDR-3 can successfully record accelerations after exceeding a predetermined trigger level with a  $\pm 10\%$  accuracy over a temperature range of  $-30^{\circ}$  to  $140^{\circ}\text{F}$ .
- f. The EDR-3 can record temperatures from  $-30^{\circ}$  to  $140^{\circ}\text{F}$  with a  $\pm 5^{\circ}\text{F}$  accuracy.
- g. The EDR-3 can be attached to the case segments without bonding to the case.

### 6.1 METROLOGY REPORT

Both EDR-3 recording units under evaluation were tested by Thiokol's Metrology Laboratory to determine their temperature measuring capability. Appendix A contains a copy of the metrology report. Both units record temperature within  $\pm 5^{\circ}\text{F}$  over the range of  $-40^{\circ}$  to  $140^{\circ}\text{F}$ .

## 6.2 TRANSPORTATION MONITORING OF ACTUAL SHIPMENTS OF HARDWARE

### 6.2.1 On-Plant Monitoring

Two on-plant hardware moves of case segments were monitored using the EDR-3 recording unit. The EDR-3s were attached using an aluminum baseplate bonded to the ring deck using STW5-3779 as shown in Figure 1 (this particular move was from the casting pit area to final assembly). The EDR-3 recording level was set to 0.5 g. No triggered vibration/shock above 0.5 g were recorded.

### 6.2.2 Off-Plant Monitoring

Several rail shipments from Corinne, UT to KSC were monitored using the EDR-3. Figure 2 shows the EDR-3 mounted to the deck of a segment rail car next to the current rail transportation monitoring unit (TMU). Figure 3 demonstrates the ability of a field operator to reduce data in the field with a laptop computer (photo taken on escort train in route to KSC). Appendix B is a complete copy of the summary data from a 23 Dec 1989 rail shipment. The maximum g level recorded for this particular shipment was 0.9 g and the temperature range was 41° to 61°F. Along with the summary reports in Appendix B are additional time versus acceleration plots for some of the triggered events. The EDR-3 is user friendly and the data produced from the data reduction software is easy to understand.

## 6.3 T-53 VIBRATION TEST FACILITY

Extensive testing at T-53 indicates that the EDR-3 measures and records accelerations extremely accurate throughout the required temperature range (-30° to 140°F).

### 6.3.1 Test Article Configuration

Figure 4 shows both EDR-3 units mounted on the test fixture on a vertical shaker in T-53. In this configuration the excitation signal is in the Z-axis. Figure 5 shows the entire shaker head assembly. Figure 6 is a complete overview of the test setup with the temperature conditioning shroud lowered over the test article.

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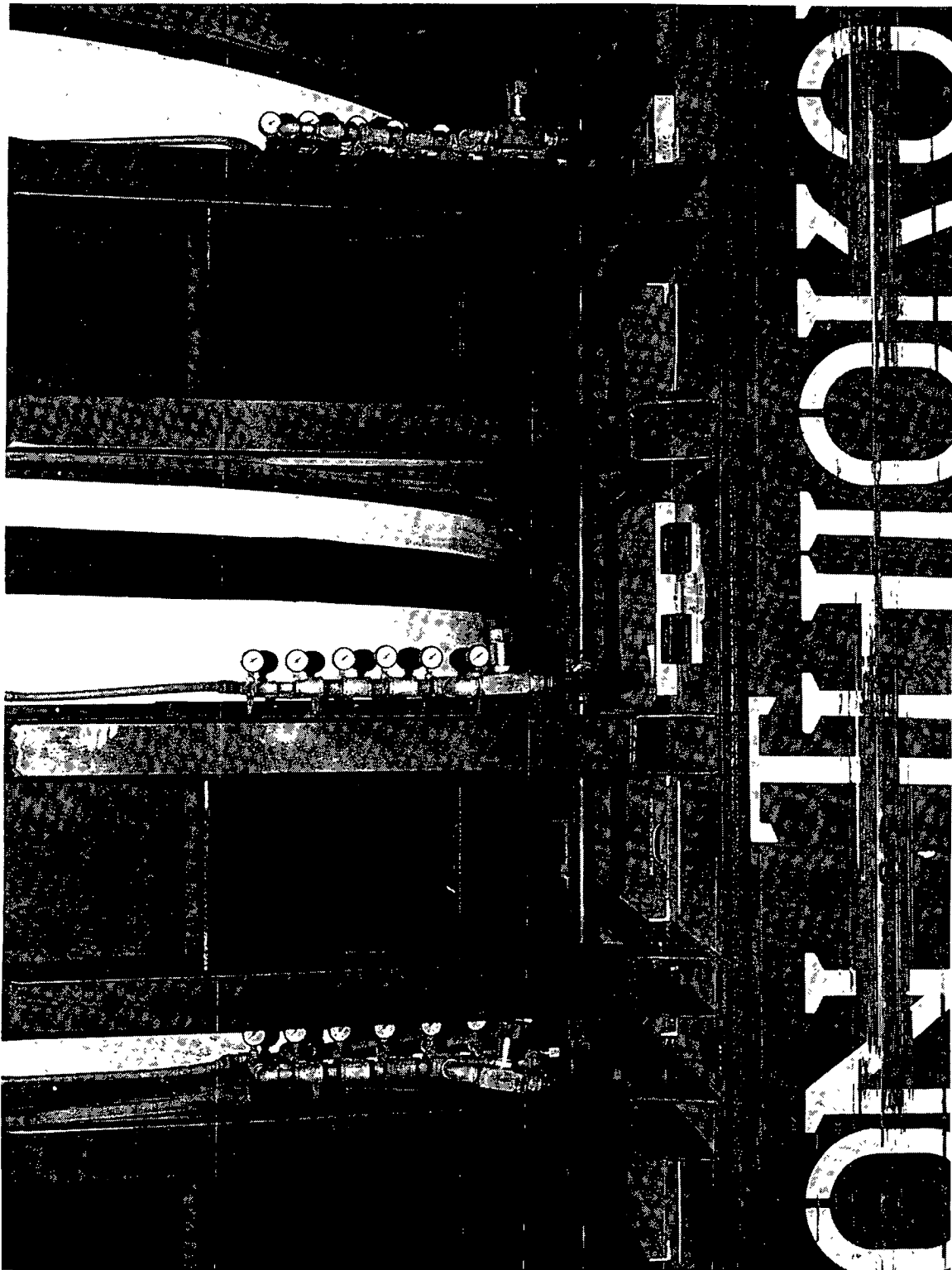


Figure 1. EDR-3 Units Attached to a Compliance Deck to Monitor an In-Plant Move

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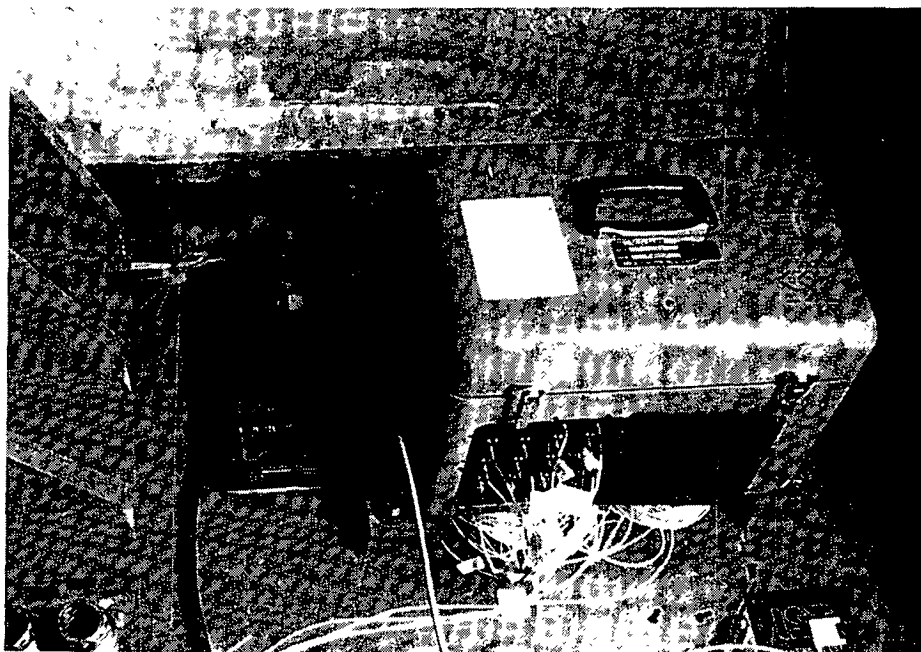


Figure 2. EDR-3 Unit Mounted on Rail Car Deck Next to TMU, Monitoring Rail Transportation

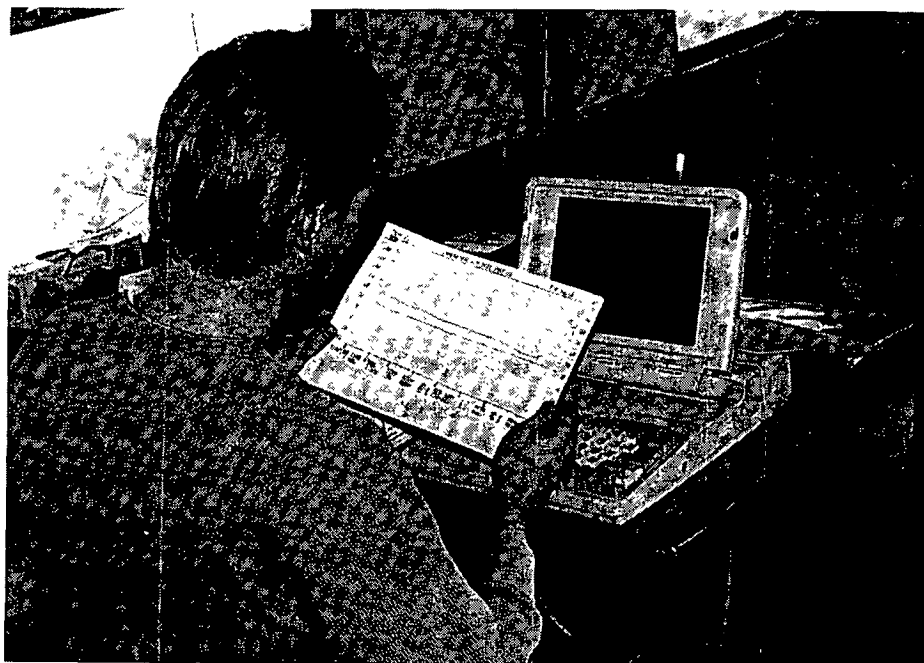


Figure 3. Train Escort Reducing Data in Route to KSC

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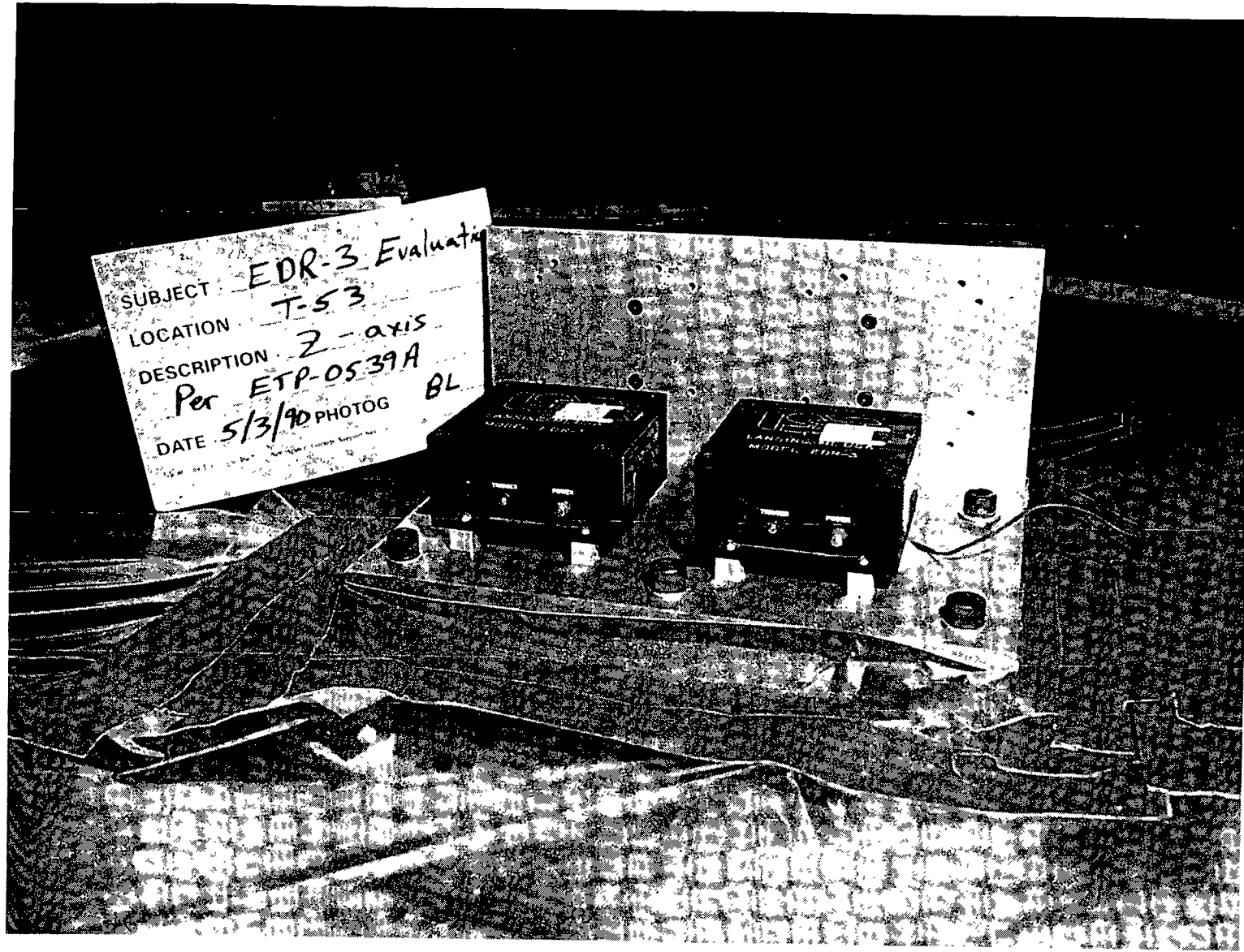


Figure 4. T-53 Vibration/Shock Testing (Z-axis)

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Figure 5. T-53 Vibration/Shock Testing in Vertical Shaker Configuration

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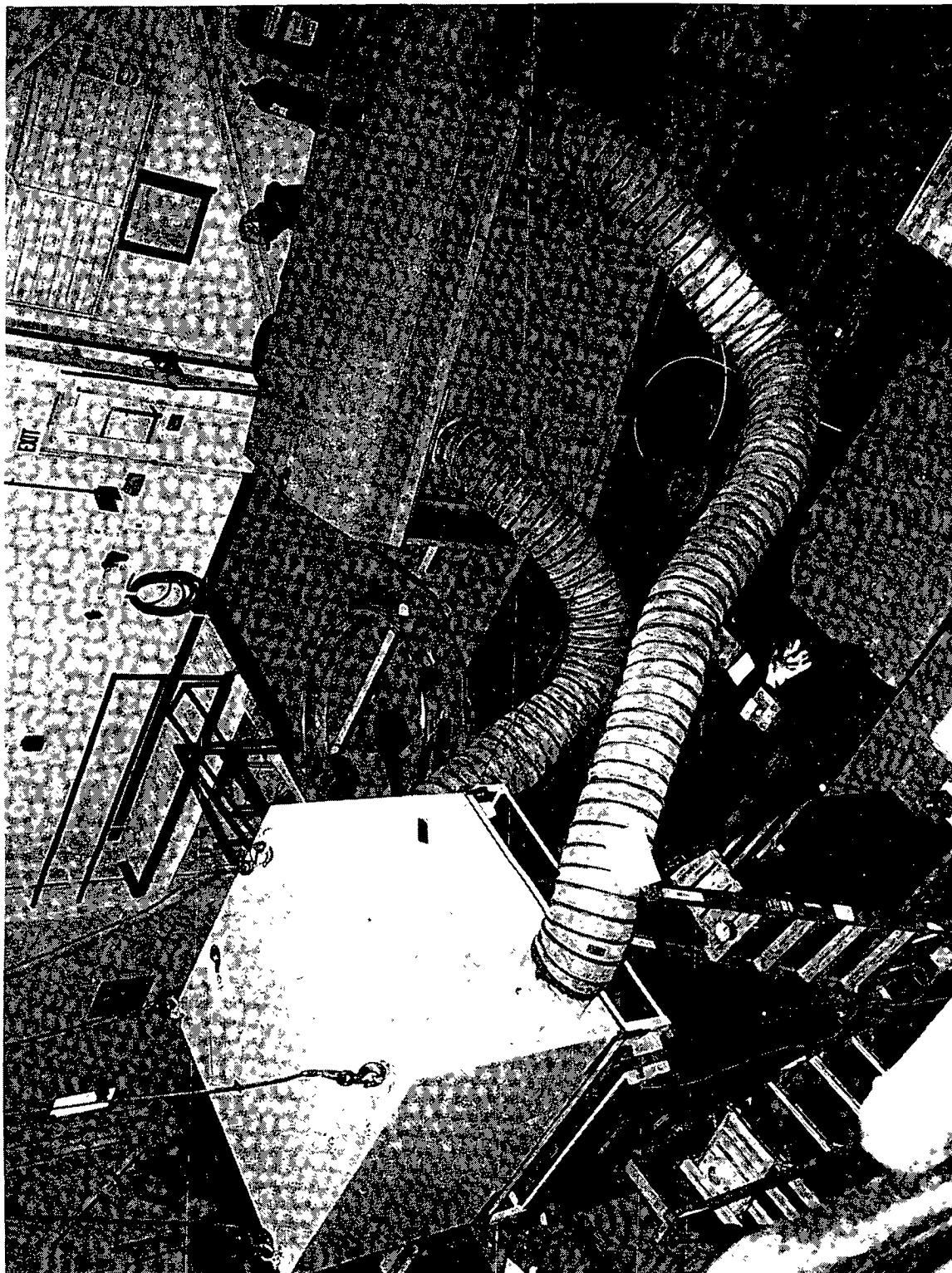


Figure 6. T-53 Environmental Conditioning Shroud Over Test Article

### 6.3.2 EDR-3 Test Configuration

The EDR-3 unit is programmable. This enables the recording parameters to be tailored to a particular type of monitoring. For T-53 testing, some of the parameters specified below were typically selected (see Appendix C for collected data):

<u>Programed Parameter</u>	<u>Typical Setting</u>	<u>Description</u>
Sample frequency	200 sps	Digital recording rate. (samples per second)
Trigger level	1.5 g	Shock/vibration g level that specifies the trigger point.
Pretrigger samples	50 samples	Number of data samples that will be recorded for each event before the trigger point.
Post-trigger samples	50 samples	Number of data samples that will be recorded for each event immediately after the initial trigger point.
Temperature/humidity measurement interval	2 min	Time interval between temperature and humidity measurements.

### 6.3.3 T-53 Test Procedures

Five types of excitation signals were used to test the EDR-3. They are listed as follows with a brief description.

<u>Excitation Signal</u>	<u>Expected Response</u>
1.0 g sine dwell at 12 Hz	This should not cause any triggered recording because the excitation signal is below the trigger point.
3.0 g sine dwell at 12 Hz	This should record several continuous events because the 3 g excitation signal is above the trigger point.
1 g half sine pulse, 0.04 sec	This should not cause any triggered recording because the excitation pulse is below the triggered point.

<u>Excitation Signal</u>	<u>Expected Response</u>
2 g half sine pulse, 0.04 sec	This should record an event for each excitation pulse because a 2 g pulse is above the 1.5 g trigger point (see Appendix C for typical data).
20 g terminal sawtooth, 0.005 sec	This should not cause any triggered recording because the frequency of the excitation signal (0.005 sec or 200 Hz) is above the EDR-3 cutoff frequency (3 dB point at 60 Hz).

In every type of excitation signal described above, the EDR-3 recorded data correctly. When the trigger point was exceeded (1.5 g), the unit recorded previous data (pretrigger length) along with data after the trigger point (post-trigger length) into the main memory of the EDR-3. Post-test analysis of the pretrigger data shows the EDR-3 does trigger accurately when the trigger threshold limit is exceeded.

#### 6.3.4 EDR-3 Accuracy

Figure 7 is a plot of the percent error versus temperature from several days of testing at T-53.

It is apparent that at temperatures below -20°F, the EDR-3 recording accuracy falls outside the acceptable 10% tolerance. A study of the problem indicated that the temperature compensation curve used during data reduction contained an error. The temperature compensation curve was corrected by the vendor and the data was reprocessed. Figure 8 shows the same data processed correctly to compensated for temperature.

#### 6.4 HAZARDS ANALYSIS

Thiokol Safety Engineering has completed a detailed hazards analysis of the EDR-3 with lithium batteries. Their findings are documented in TWR-50206. Safety Engineering's recommendations (see page 2, TWR-50206) can be implemented which will reduce the hazard probability rating of the EDR-3 to "Remote" ("small chance of ever occurring"). The new EDR-3-10 with remote data communication capabilities enables use without ever removing the lid on the instrument. This means that the battery compartment will never be exposed near a RSRM, KSC, or anywhere else.

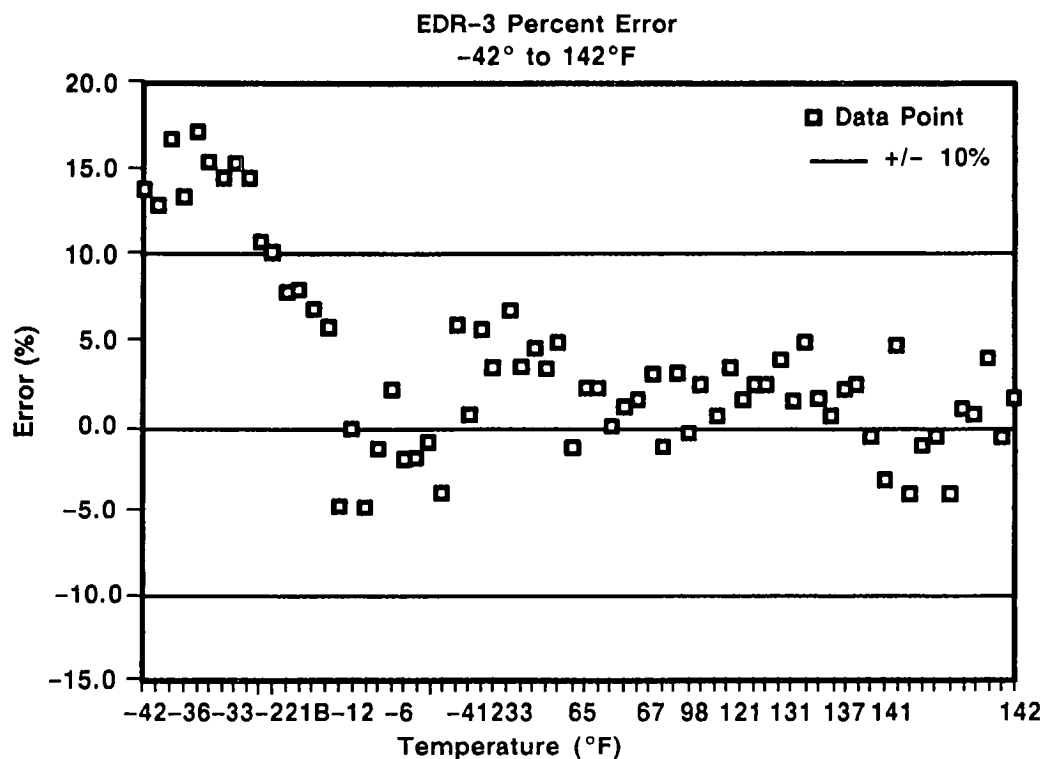


Figure 7. Processed T-53 Data With Incorrect Temperature Compensation Curve

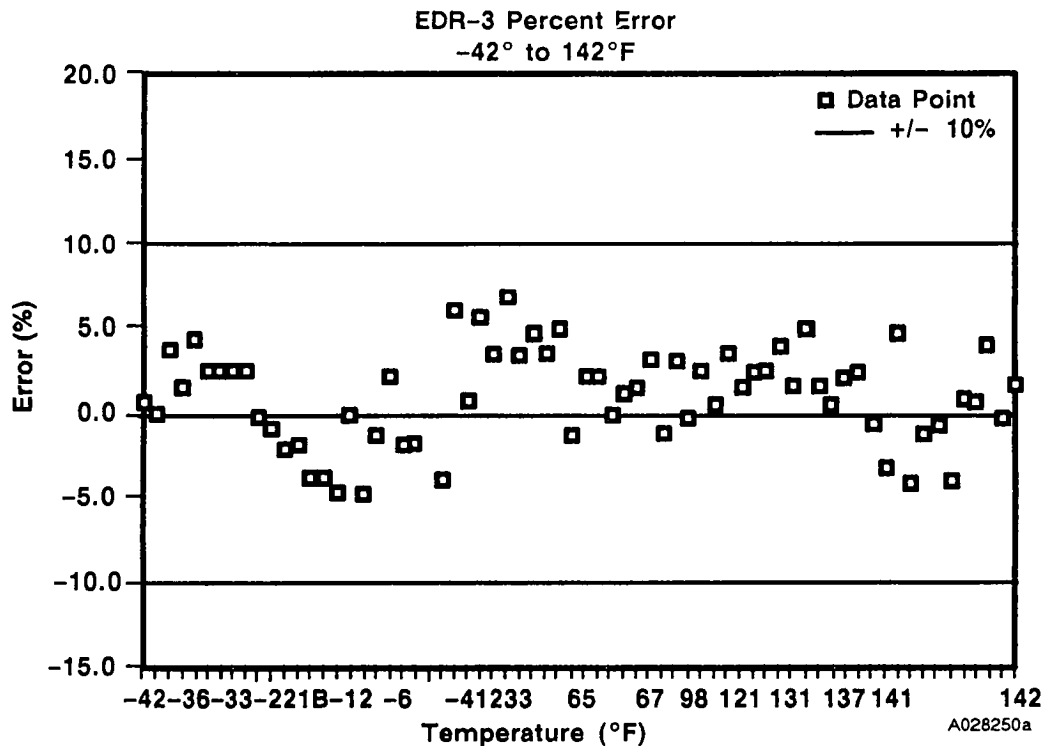


Figure 8. Processed T-53 Data With Corrected Temperature Compensation Curve

The only time the instrument will be opened is during refurbishment at which time the batteries will be replaced.

## 6.5 POWER SUPPLY

The EDR-3 is powered by eight standard, off-the-shelf, lithium, 9-V batteries manufactured by Ultra Technologies Inc., a subsidiary of Eastman Kodak Company. The product name of the battery is Kodak Ultralife Lithium Power Cell (9 V). Detail information about the 9-V lithium battery can be found in TWR-50206.

### 6.5.1 Battery Life

Battery life is primarily a function of the digital sample frequency, temperature, and the number of triggered acceleration events recorded. The following estimates were provided by IST using the battery manufacturer's ratings for amp-hour capacity and experimentally measured EDR-3 power consumptions. The estimates were calculated using a 2,000 Hz digital sample rate. Thiokol digital sampling rate for rail shipments is significantly lower (200 Hz) and will increase battery life as much as 30% above the figures listed as follows:

<u>Temperature</u> <u>(°F)</u>	<u>Number of days of operation (lithium battery)</u>	
77	48	57*
-40	38	45*

\*Thiokol estimates assuming a conservative 20% increase in battery life due to the slow digital sample rate required to monitor rail shipments

## 6.6 MAGNETIC MOUNTS FOR EDR-3

During the evaluation, Design Engineering studied the possibility of using magnets to attach the EDR-3 to a SRM case segment. IST was consulted to provide such an attachment. Within weeks, IST sent to Thiokol a sample prototype. Figures 9 and 10 show an EDR-3 with two magnet bars attached to the sides of the instrument. Each magnet has a rated pull strength of 75 lb. The magnets are machined to the actual circumferential curve of the case segment for maximum contact surface.

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Figure 9. EDR-3 With Magnetic Bar

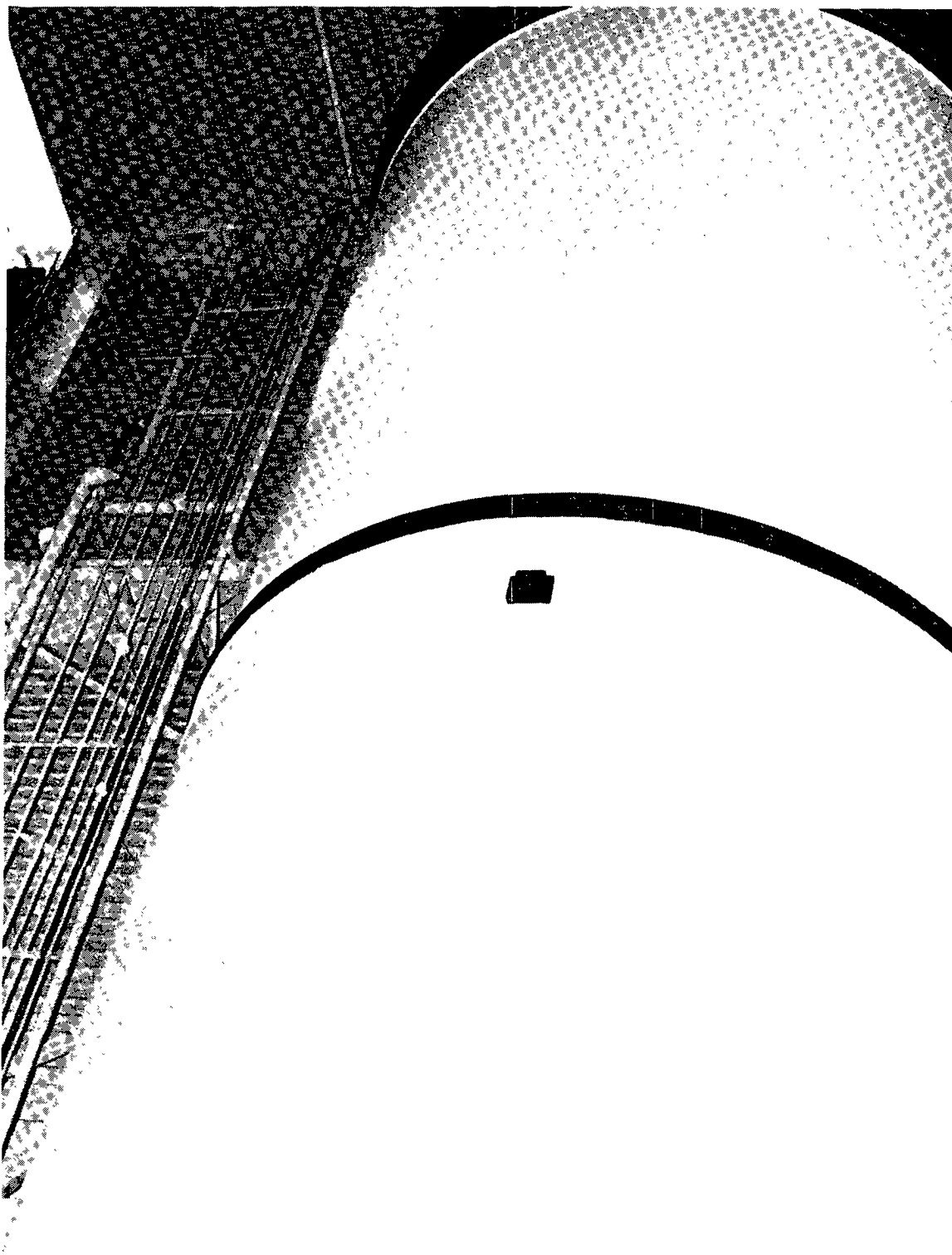


Figure 10. EDR-3 Mounted to RSRM Segment

#### 6.6.1 Magnetic Mount Testing at T-53

On 14 Jun 1990, magnetic mount testing was conducted at T-53. Two types of excitation signals were used to evaluate the magnetic mounts as described as follows. A special test fixture was built which simulated attachment to a RSRM case segment. The magnetic mounts were attached to an actual piece of case segment which had a coat of primer and paint (Figure 11).

Testing was conducted in all three axes.

##### Sine sweep excitation signal

5 to 130 Hz at 1.2 g peak

130 to 185 Hz at 0.0014 in. double amplitude (DA)

185 to 2,000 Hz at 2.5 g peak

Sine sweep at 5 to 2,000 Hz at 1 oct/min

Results: EDR-3 moved from position when tested in all three axes during sine sweep in the frequency range of 300 to 340 Hz. This was due to the resonant frequency of the test fixture and is not a cause for concern. There was no movement in the lower frequencies which are typical of rail transportation environment.

##### 20 g shock excitation signal

20 g terminal sawtooth at 200 Hz

Results: EDR-3 moved approximately 0.125 in. when tested in the vertical and tangential axes. The magnetic mount never failed to keep the unit attached to the case. During case shipments to KSC, RSRM segments very rarely see any vibration/shock over 1.5 g. Therefore, this movement at such an extreme should not disqualify the magnetic mount attachment. Lower level shocks did not move the EDR-3.

Magnetic mounts for the EDR-3 supplied by the vendor are an acceptable attachment for low frequency, low g-level, vibration\shock monitoring during rail transportation. The current magnetic design requires approximately 150 lb force to pull the EDR-3 off bare metal.

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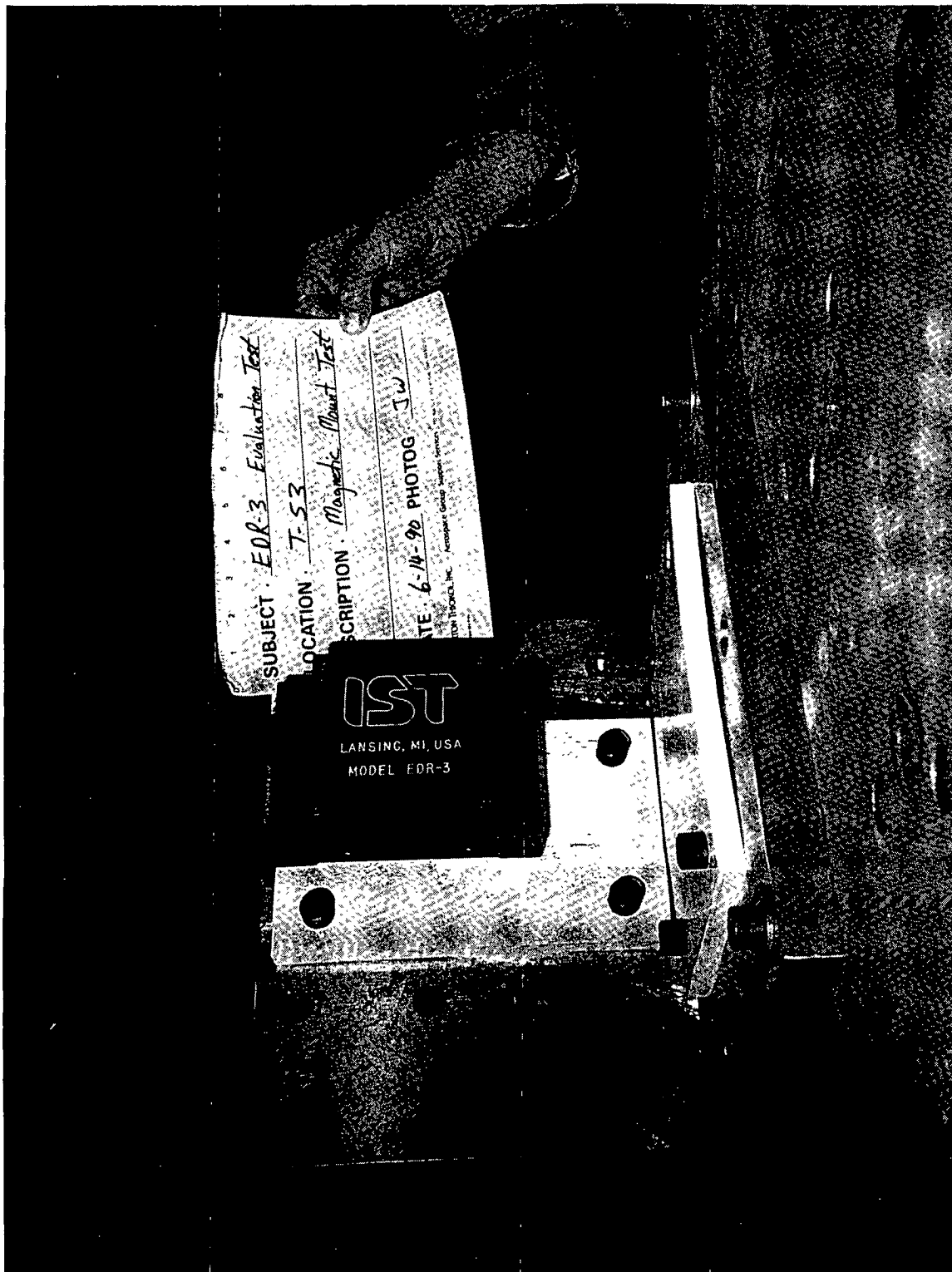


Figure 11. T-53 Magnetic Mount Testing (vertical axis)

## APPLICABLE DOCUMENTS

The latest revision of the following documents are applicable to the extent specified herein.

<u>Document Numbers</u>	<u>Title</u>
No number	Environmental Shock and Vibration Sensor/Recorder, Model EDR-3 (Vendor specification is attached)
STW5-3779	Cement, Plastic Adhesive
TWR-50206	Model EDR-3 Temperature, Humidity and Acceleration Monitor/Recording Unit Hazards Analysis No. 90-229
Program Directive No. 53	Requires the implementation of controls during manufacture, in-plant transportation, transfer of flight hardware to rail-loading site at X-16 and loading operations to ensure flight hardware is not exposed to ambient temperatures.
ETP-0539	Evaluation of EDR-3 Vibration, Shock, Temperature, and Humidity Recording Unit.
CPW1-3600A	Prime Equipment Contract End Item (CEI) Detail Specification.
CDW2-3847	Performance, Design and Verification Requirement Transportation Environmental Recording Unit, Model Designator, P77-0491
MIL-STD-45662	Calibration System Requirement

Appendix A

Metrology Lab Report No. 011, EDR-3 Recording Unit

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**Thiokol** CORPORATION  
STRATEGIC OPERATIONS

17 November 1989

METROLOGY LABORATORY  
CALIBRATION REPORT NO. 011

Instrumented Sensor Technology Model EDR-3  
S/N 8907260003-3 and S/N 8907260003-4

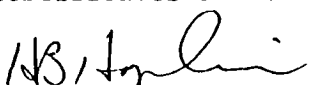
Submitted By: Kevin Rees, M.S. L62B, Ext. 6471  
Calibration Date: 17 November 1989  
Calibration Procedure: DI-0134

TEMPERATURE READINGS, DEG. F.				% HUMIDITY READINGS		
APPLIED TEMP.	S/N -3 READING	S/N -3 DEVIATION		APPLIED HUMIDITY	S/N -3 READING	S/N -3 DEVIATION
-37.3	-41	3.7 low		20.0%	27%	7.0% high
6.5	3	3.5 low		75.2%	84%	8.8% high
50.9	47	3.9 low				
95.1	92	3.1 low				
139.3	137	2.3 low				

TEMPERATURE READINGS, DEG. F.				% HUMIDITY READINGS		
APPLIED TEMP.	S/N -4 READING	S/N -4 DEVIATION		APPLIED HUMIDITY	S/N -4 READING	S/N -4 DEVIATION
-37.3	-37	0.3 low		20.0%	24%	4.0% high
6.5	5	1.5 low		75.2%	79%	3.8% high
50.9	48	2.9 low				
95.1	92	3.1 low				
139.3	135	4.3 low				

The Thiokol Corporation Metrology Laboratory operates in full compliance to MIL-STD-45662 in an environmentally controlled facility.

All calibrations are performed with standards which are directly traceable to the National Institute of Standards and Technology. Certificates are on file and may be inspected upon request.

  
H. B. Hopkins, Supervisor  
Thiokol Corporation Metrology Laboratory

HBH/DLM/gh

P.O. Box 689, Brigham City, UT 84302-0689 (801) 863-3511

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Appendix B  
Rail Car Shipment Data

## Appendix B

### Rail Car Shipment Data

23 Dec 1989 Rail Shipment of the RSRM, 11A aft center segment. Complete EDR-3 generated summary reports and selected time history plots, time versus acceleration.

<u>Page</u>	<u>Description</u>
B-3	EDR-3 Recording Unit Documentation report. This report contains user information, shipper information, and vibration recording parameters.
B-4	Top-EDR-3 Recording Unit Statistical Summary report. This report summarizes the maximum, minimum, and mean recorded values of temperature, humidity, vibration.
B-4	Bottom-Time Versus Temperature and Humidity Plot (temperature and humidity measured every 30 min).
B-5	Triggered Events - Vibration Frame report. This report shows that there were 11 triggered events on this shipment (0.44-g trigger level).
B-6 through B-13	EDR-3 Recording Unit Temperature/Humidity report
B-14	Acceleration (g) Versus Time Plot for Event No. 1 (all axes)
B-15	Top-Expanded Acceleration (g) Versus Time Plot for Event No. 1 (X-axis)
B-15	Bottom-Expanded Acceleration (g) Versus Time Plot for Event No. 1 (Z-axis)
B-16	Acceleration (g) Versus Time Plot for Event No. 2 (all axes)
B-17	Top-Expanded Acceleration (g) Versus Time Plot for Event No. 2 (X-axis)
B-17	Bottom-Expanded Acceleration (g) Versus Time Plot for Event No. 2 (Z-axis)
B-18	Power Spectral Density (PSD) Plot

Environmental Data Recorder: USER DOCUMENTATION

Report Date: 05-21-1990

Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

Recording Start Date: 12/22/89  
Time: 14:09:02

Recording End Date: 12/29/89  
Time: 09:06:35

FILENAME: dec23han

USER ID: Kevin Rees

ORIGIN: Corinne, UT

DESTINATION: KSC, FL

SHIPPER: UP, KCS, CSX, and KEC Railroads

CARRIER:

MODE: Railroad

COMMENTS: EDR-3, Unit 4, Evaluation Test  
X-axis vert., Y-axis tan., Z-axis long

RECORDING CONTROL PARAMETERS

SAMPLE FREQUENCY(Hz): 150

TRIGGER LEVEL(gs): .44

TRIGGER DURATION THRESHOLD: 5

PRE-TRIGGER SAMPLES: 150

POST-TRIGGER SAMPLES: 600

CHANNEL SELECT--: (0=(PR-int), 1=(PE-ext) ) 0

MEMORY MODE----: (0=fill&stop 1=overwrite) 1

MAXIMUM No. EVENTS: (MEM MODE 1=req. for PSDs) 60

TIME-TRIG DELAY: (min seconds between EVs) 0

MAXIMUM EV LENGTH: 2047

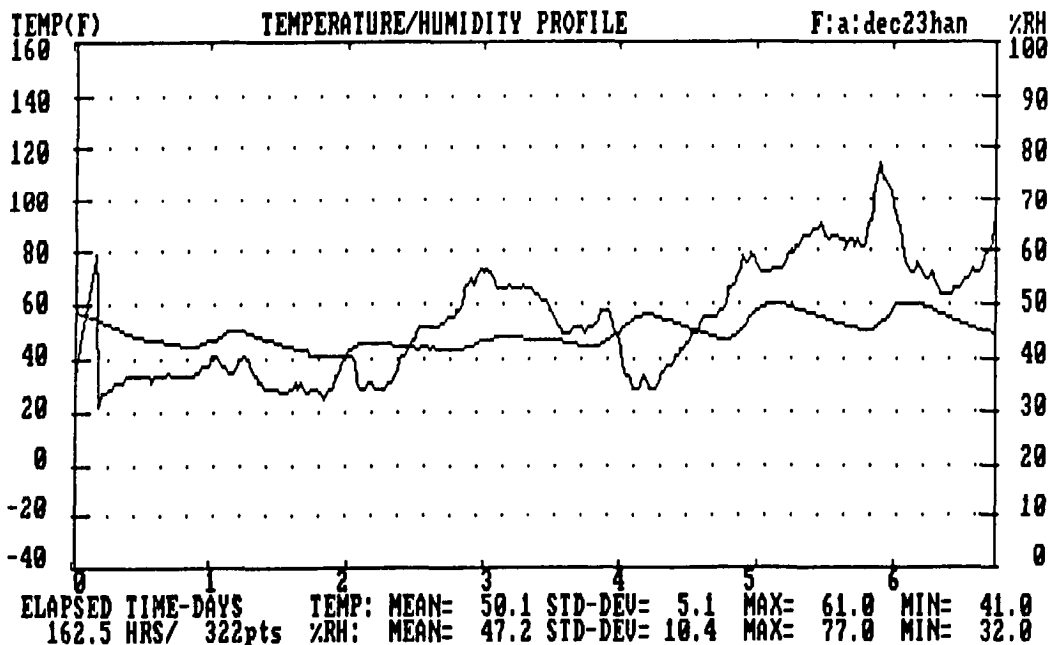
Environmental Data Recorder: STATISTICAL SUMMARY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 11 Acceleration Frames

		A C C E L E R A T I O N   S T A T I S T I C S					
		--Channel-1 (x)----		Channel-2 (y)----		Channel-3 (z)----	
Peak Accel. G-Levels	max.....	0.7/	-0.9 ...	0.5/	-0.5 ...	0.5/	-0.52 ...
	min.....	0.5/	-0.4 ...	0.0/	-0.1 ...	0.1/	-0.15 ...
	mean.....	0.6/	-0.6 ...	0.2/	-0.2 ...	0.2/	-0.29 ...
	std-dev....	0.1/	0.2 ...	0.1/	0.1 ...	0.1/	0.14 ...
RMS G Levels	max.....	0.16	...	0.1	...	0.09	...
	min.....	0.07	...	0.0	...	0.03	...
	mean.....	0.12	...	0.1	...	0.06	...
	std-dev....	0.03	...	0.0	...	0.02	...
Crest Factor	max.....	7.71	...	5.9	...	6.28	...
	min.....	4.16	...	3.8	...	3.54	...
	mean.....	5.71	...	4.5	...	5.05	...
	std-dev....	1.15	...	0.6	...	0.86	...

		-TEMPERATURE---%RELATIVE HUMIDITY-	
max.....	61.00 ...	77.0	...
min.....	41.00 ...	32.0	...
mean.....	50.10 ...	47.2	...
std-dev....	5.13 ...	10.4	...



VIBRATION FRAME REPORT

Report Date: 05-21-1990

Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

Temperatures

File Contains 11 Acceleration Frames

No.	Date	Time	Peak G levels						RMS levels			Crest Factors		
			+ 1-x -	+ 2-y -	+ 3-z -	1-x	2-y	3-z	1-x	2-y	3-z			
112/23/89	12:38:30		0.7/ 0.4	0.0/ 0.1	0.4/ 0.5	0.1	0.0	0.1	7.3	4.4	6.1			
212/23/89	23:27:02		0.5/ 0.4	0.1/ 0.1	0.3/ 0.4	0.1	0.0	0.1	6.5	5.9	5.9			
312/25/89	05:43:04		0.6/ 0.6	0.3/ 0.4	0.2/ 0.2	0.2	0.1	0.1	4.2	4.0	3.5			
412/25/89	15:05:09		0.5/ 0.5	0.2/ 0.1	0.1/ 0.2	0.1	0.0	0.0	5.1	4.7	5.0			
512/25/89	15:49:48		0.6/ 0.7	0.1/ 0.1	0.2/ 0.2	0.1	0.0	0.0	5.8	3.8	5.1			
612/25/89	23:18:46		0.5/ 0.5	0.0/ 0.1	0.5/ 0.4	0.1	0.0	0.1	6.5	4.6	6.3			
712/26/89	21:09:53		0.7/ 0.5	0.5/ 0.5	0.2/ 0.2	0.1	0.1	0.0	4.9	3.9	4.5			
812/28/89	03:38:02		0.6/ 0.6	0.4/ 0.3	0.2/ 0.2	0.1	0.1	0.1	4.3	4.9	4.7			
912/28/89	03:38:07		0.5/ 0.7	0.3/ 0.3	0.2/ 0.2	0.1	0.1	0.0	4.7	3.8	4.0			
1012/28/89	19:17:27		0.6/ 0.9	0.2/ 0.1	0.3/ 0.5	0.1	0.0	0.1	7.7	4.6	5.9			
1112/29/89	02:16:00		0.6/ 0.5	0.2/ 0.2	0.1/ 0.2	0.1	0.0	0.0	5.9	4.7	4.6			

Vert. Tan. Long.

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
1	12/22/89	14:09:02	58	38
2	12/22/89	17:39:39	56	60
3	12/22/89	18:09:27	55	32
4	12/22/89	18:39:16	55	34
5	12/22/89	19:09:04	54	34
6	12/22/89	19:38:53	54	34
7	12/22/89	20:08:42	54	35
8	12/22/89	20:38:30	52	35
9	12/22/89	21:08:19	52	36
10	12/22/89	21:38:07	52	36
11	12/22/89	22:07:56	51	36
12	12/22/89	22:37:44	51	36
13	12/22/89	23:07:33	50	37
14	12/22/89	23:37:22	50	37
15	12/23/89	00:07:10	50	37
16	12/23/89	00:36:59	49	37
17	12/23/89	01:06:47	49	37
18	12/23/89	01:36:36	49	37
19	12/23/89	02:06:25	49	37
20	12/23/89	02:36:13	48	37
21	12/23/89	03:06:02	48	37
22	12/23/89	03:35:50	48	36
23	12/23/89	04:05:39	48	37
24	12/23/89	04:35:28	47	37
25	12/23/89	05:05:16	47	37
26	12/23/89	05:35:05	47	37
27	12/23/89	06:04:53	46	37
28	12/23/89	06:34:42	46	38
29	12/23/89	07:04:30	46	37
30	12/23/89	07:34:19	46	37
31	12/23/89	08:04:08	46	37
32	12/23/89	08:33:56	46	37
33	12/23/89	09:03:45	45	37
34	12/23/89	09:33:33	45	37
35	12/23/89	10:03:22	45	37
36	12/23/89	10:33:11	45	37
37	12/23/89	11:02:59	45	37
38	12/23/89	11:32:48	45	38
39	12/23/89	12:02:36	45	38
40	12/23/89	12:32:25	46	39
41	12/23/89	13:02:13	46	39
42	12/23/89	13:32:02	47	39
43	12/23/89	14:01:51	47	40
44	12/23/89	14:31:39	47	41

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
45	12/23/89	15:01:28	48	41
46	12/23/89	15:31:16	49	40
47	12/23/89	16:01:05	49	39
48	12/23/89	16:30:54	50	39
49	12/23/89	17:00:42	51	38
50	12/23/89	17:30:31	51	38
51	12/23/89	18:00:19	51	38
52	12/23/89	18:30:08	51	39
53	12/23/89	18:59:57	51	40
54	12/23/89	19:29:45	51	40
55	12/23/89	19:59:34	51	41
56	12/23/89	20:29:22	50	40
57	12/23/89	20:59:11	50	39
58	12/23/89	21:28:59	50	38
59	12/23/89	21:58:48	49	37
60	12/23/89	22:28:37	49	36
61	12/23/89	22:58:25	49	36
62	12/23/89	23:28:14	48	35
63	12/23/89	23:58:02	48	35
64	12/24/89	00:27:51	47	35
65	12/24/89	00:57:40	47	35
66	12/24/89	01:27:28	46	35
67	12/24/89	01:57:17	46	35
68	12/24/89	02:27:05	46	34
69	12/24/89	02:56:54	45	34
70	12/24/89	03:26:42	45	34
71	12/24/89	03:56:31	45	35
72	12/24/89	04:26:20	45	35
73	12/24/89	04:56:08	44	36
74	12/24/89	05:25:57	44	35
75	12/24/89	05:55:45	44	36
76	12/24/89	06:25:34	44	35
77	12/24/89	06:55:23	44	34
78	12/24/89	07:25:11	42	34
79	12/24/89	07:55:00	42	35
80	12/24/89	08:24:48	42	35
81	12/24/89	08:54:37	42	35
82	12/24/89	09:24:26	41	34
83	12/24/89	09:54:14	41	33
84	12/24/89	10:24:03	41	34
85	12/24/89	10:53:51	41	35
86	12/24/89	11:23:40	41	35
87	12/24/89	11:53:28	41	37
88	12/24/89	12:23:17	41	37

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
89	12/24/89	12:53:06	42	39
90	12/24/89	13:22:54	42	40
91	12/24/89	13:52:43	42	41
92	12/24/89	14:22:31	44	41
93	12/24/89	14:52:20	44	41
94	12/24/89	15:22:09	45	39
95	12/24/89	15:51:57	45	36
96	12/24/89	16:21:46	46	35
97	12/24/89	16:51:34	46	35
98	12/24/89	17:21:23	46	35
99	12/24/89	17:51:11	46	36
100	12/24/89	18:21:00	46	36
101	12/24/89	18:50:49	46	35
102	12/24/89	19:20:37	46	35
103	12/24/89	19:50:26	46	35
104	12/24/89	20:20:14	46	35
105	12/24/89	20:50:03	46	35
106	12/24/89	21:19:52	46	36
107	12/24/89	21:49:40	46	36
108	12/24/89	22:19:29	45	37
109	12/24/89	22:49:17	45	38
110	12/24/89	23:19:06	45	40
111	12/24/89	23:48:55	45	41
112	12/25/89	00:18:43	45	41
113	12/25/89	00:48:32	45	42
114	12/25/89	01:18:20	45	43
115	12/25/89	01:48:09	45	44
116	12/25/89	02:17:57	44	45
117	12/25/89	02:47:46	44	46
118	12/25/89	03:17:35	45	46
119	12/25/89	03:47:23	45	46
120	12/25/89	04:17:12	45	46
121	12/25/89	04:47:00	44	46
122	12/25/89	05:16:49	45	46
123	12/25/89	05:46:38	44	46
124	12/25/89	06:16:26	44	46
125	12/25/89	06:46:15	44	47
126	12/25/89	07:16:03	44	47
127	12/25/89	07:45:52	44	48
128	12/25/89	08:15:41	44	48
129	12/25/89	08:45:29	44	48
130	12/25/89	09:15:18	44	49
131	12/25/89	09:45:06	44	49
132	12/25/89	10:14:55	44	50

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
133	12/25/89	10:44:43	44	53
134	12/25/89	11:14:32	45	54
135	12/25/89	11:44:21	45	55
136	12/25/89	12:14:09	45	54
137	12/25/89	12:43:58	46	55
138	12/25/89	13:13:46	46	56
139	12/25/89	13:43:35	47	57
140	12/25/89	14:13:24	47	56
141	12/25/89	14:43:12	48	57
142	12/25/89	15:13:01	48	56
143	12/25/89	15:42:49	48	55
144	12/25/89	16:12:38	49	54
145	12/25/89	16:42:26	49	53
146	12/25/89	17:12:15	49	53
147	12/25/89	17:42:04	49	53
148	12/25/89	18:11:52	49	53
149	12/25/89	18:41:41	49	54
150	12/25/89	19:11:29	49	53
151	12/25/89	19:41:18	49	53
152	12/25/89	20:11:07	49	53
153	12/25/89	20:40:55	49	53
154	12/25/89	21:10:44	49	54
155	12/25/89	21:40:32	48	53
156	12/25/89	22:10:21	48	53
157	12/25/89	22:40:10	48	53
158	12/25/89	23:09:58	48	52
159	12/25/89	23:39:47	48	52
160	12/26/89	00:09:35	48	51
161	12/26/89	00:39:24	48	51
162	12/26/89	01:09:12	48	51
163	12/26/89	01:39:01	48	49
164	12/26/89	02:08:50	48	49
165	12/26/89	02:38:38	47	48
166	12/26/89	03:08:27	47	47
167	12/26/89	03:38:15	47	46
168	12/26/89	04:08:04	47	45
169	12/26/89	04:37:53	46	45
170	12/26/89	05:07:41	46	45
171	12/26/89	05:37:30	46	45
172	12/26/89	06:07:18	46	46
173	12/26/89	06:37:07	46	46
174	12/26/89	07:06:55	45	46
175	12/26/89	07:36:44	45	46
176	12/26/89	08:06:33	45	45

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL. HUMIDITY
177	12/26/89	08:36:21	45	46
178	12/26/89	09:06:10	45	46
179	12/26/89	09:35:58	45	46
180	12/26/89	10:05:47	45	47
181	12/26/89	10:35:36	45	49
182	12/26/89	11:05:24	46	49
183	12/26/89	11:35:13	46	49
184	12/26/89	12:05:01	47	49
185	12/26/89	12:34:50	47	48
186	12/26/89	13:04:39	49	46
187	12/26/89	13:34:27	50	45
188	12/26/89	14:04:16	50	43
189	12/26/89	14:34:04	51	41
190	12/26/89	15:03:53	52	38
191	12/26/89	15:33:41	54	37
192	12/26/89	16:03:30	54	37
193	12/26/89	16:33:19	55	35
194	12/26/89	17:03:07	56	35
195	12/26/89	17:32:56	56	35
196	12/26/89	18:02:44	56	36
197	12/26/89	18:32:33	57	37
198	12/26/89	19:02:22	57	36
199	12/26/89	19:32:10	57	35
200	12/26/89	20:01:59	57	35
201	12/26/89	20:31:47	56	35
202	12/26/89	21:01:36	56	36
203	12/26/89	21:31:25	56	37
204	12/26/89	22:01:13	55	38
205	12/26/89	22:31:02	55	39
206	12/26/89	23:00:50	55	39
207	12/26/89	23:30:39	55	39
208	12/27/89	00:00:27	54	41
209	12/27/89	00:30:16	54	41
210	12/27/89	01:00:05	54	42
211	12/27/89	01:29:53	52	42
212	12/27/89	01:59:42	52	43
213	12/27/89	02:29:30	52	43
214	12/27/89	02:59:19	51	45
215	12/27/89	03:29:08	51	45
216	12/27/89	03:58:56	51	45
217	12/27/89	04:28:45	51	47
218	12/27/89	04:58:33	50	48
219	12/27/89	05:28:22	50	48
220	12/27/89	05:58:10	50	48

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT

Report Date:05-21-1990

Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
221	12/27/89	06:27:59	49	48
222	12/27/89	06:57:48	49	48
223	12/27/89	07:27:36	49	48
224	12/27/89	07:57:25	48	49
225	12/27/89	08:27:13	48	49
226	12/27/89	08:57:02	48	51
227	12/27/89	09:26:51	48	53
228	12/27/89	09:56:39	48	53
229	12/27/89	10:26:28	49	54
230	12/27/89	10:56:16	49	55
231	12/27/89	11:26:05	50	56
232	12/27/89	11:55:54	51	59
233	12/27/89	12:25:42	52	58
234	12/27/89	12:55:31	55	58
235	12/27/89	13:25:19	56	60
236	12/27/89	13:55:08	57	59
237	12/27/89	14:24:56	58	58
238	12/27/89	14:54:45	58	57
239	12/27/89	15:24:34	59	56
240	12/27/89	15:54:22	59	56
241	12/27/89	16:24:11	60	56
242	12/27/89	16:53:59	60	56
243	12/27/89	17:23:48	60	57
244	12/27/89	17:53:37	60	57
245	12/27/89	18:23:25	60	57
246	12/27/89	18:53:14	60	57
247	12/27/89	19:23:02	60	58
248	12/27/89	19:52:51	59	59
249	12/27/89	20:22:39	59	60
250	12/27/89	20:52:28	59	60
251	12/27/89	21:22:17	58	61
252	12/27/89	21:52:05	58	61
253	12/27/89	22:21:54	58	62
254	12/27/89	22:51:42	58	63
255	12/27/89	23:21:31	57	63
256	12/27/89	23:51:20	57	63
257	12/28/89	00:21:08	57	64
258	12/28/89	00:50:57	57	64
259	12/28/89	01:20:45	56	64
260	12/28/89	01:50:34	56	65
261	12/28/89	02:20:23	56	63
262	12/28/89	02:50:11	55	63
263	12/28/89	03:20:00	55	62
264	12/28/89	03:49:48	55	63

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-21-1990  
Report Ident: Shipment of 11A Aft-Ctr Segment

File: dec23han

File Contains 322 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
265	12/28/89	04:19:37	54	63
266	12/28/89	04:49:25	54	63
267	12/28/89	05:19:14	54	62
268	12/28/89	05:49:03	54	62
269	12/28/89	06:18:51	52	61
270	12/28/89	06:48:40	52	62
271	12/28/89	07:18:28	52	62
272	12/28/89	07:48:17	52	61
273	12/28/89	08:18:06	52	62
274	12/28/89	08:47:54	51	61
275	12/28/89	09:17:43	51	61
276	12/28/89	09:47:31	51	62
277	12/28/89	10:17:20	51	65
278	12/28/89	10:47:09	51	66
279	12/28/89	11:16:57	51	71
280	12/28/89	11:46:46	52	75
281	12/28/89	12:16:34	54	77
282	12/28/89	12:46:23	55	74
283	12/28/89	13:16:11	55	74
284	12/28/89	13:46:00	56	73
285	12/28/89	14:15:49	58	71
286	12/28/89	14:45:37	59	68
287	12/28/89	15:15:26	60	66
288	12/28/89	15:45:14	60	64
289	12/28/89	16:15:03	61	61
290	12/28/89	16:44:52	61	58
291	12/28/89	17:14:40	61	57
292	12/28/89	17:44:29	61	56
293	12/28/89	18:14:17	61	56
294	12/28/89	18:44:06	61	58
295	12/28/89	19:13:54	60	57
296	12/28/89	19:43:43	60	56
297	12/28/89	20:13:32	59	55
298	12/28/89	20:43:20	59	55
299	12/28/89	21:13:09	59	56
300	12/28/89	21:42:57	58	55
301	12/28/89	22:12:46	58	54
302	12/28/89	22:42:35	57	52
303	12/28/89	23:12:23	57	52
304	12/28/89	23:42:12	57	52
305	12/29/89	00:12:00	56	52
306	12/29/89	00:41:49	56	52
307	12/29/89	01:11:38	55	53
308	12/29/89	01:41:26	55	53

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT

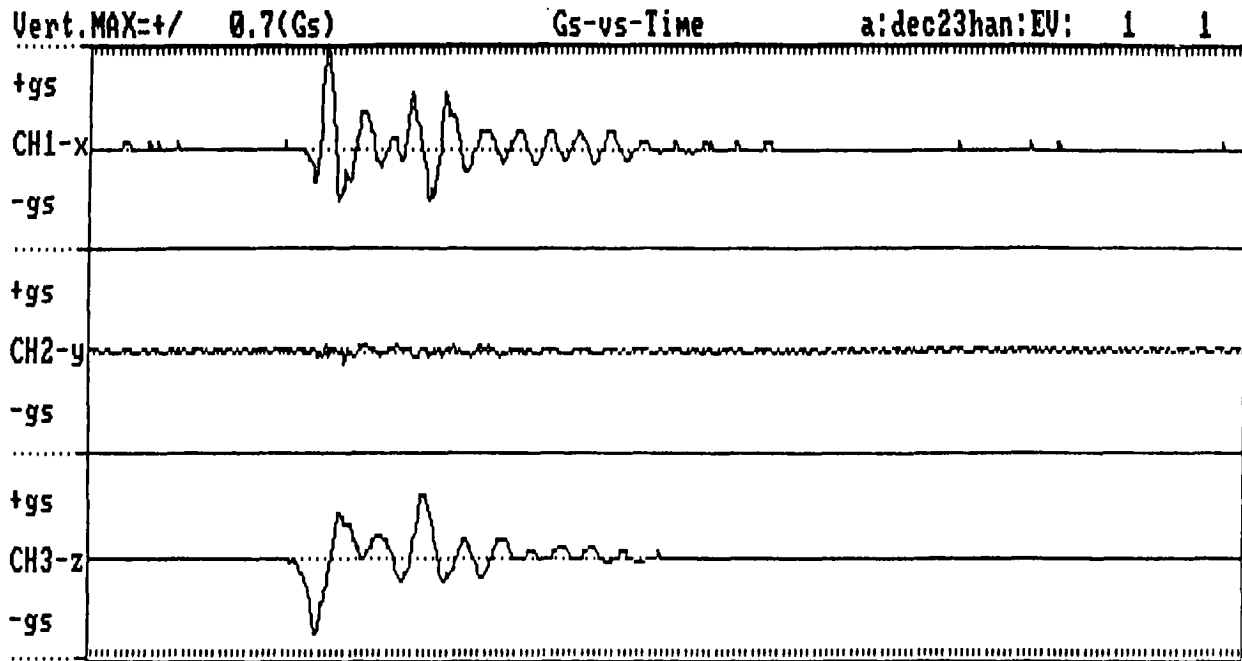
Report Date: 05-21-1990

Report Ident: Shipment of 11A Aft-Ctr Segment

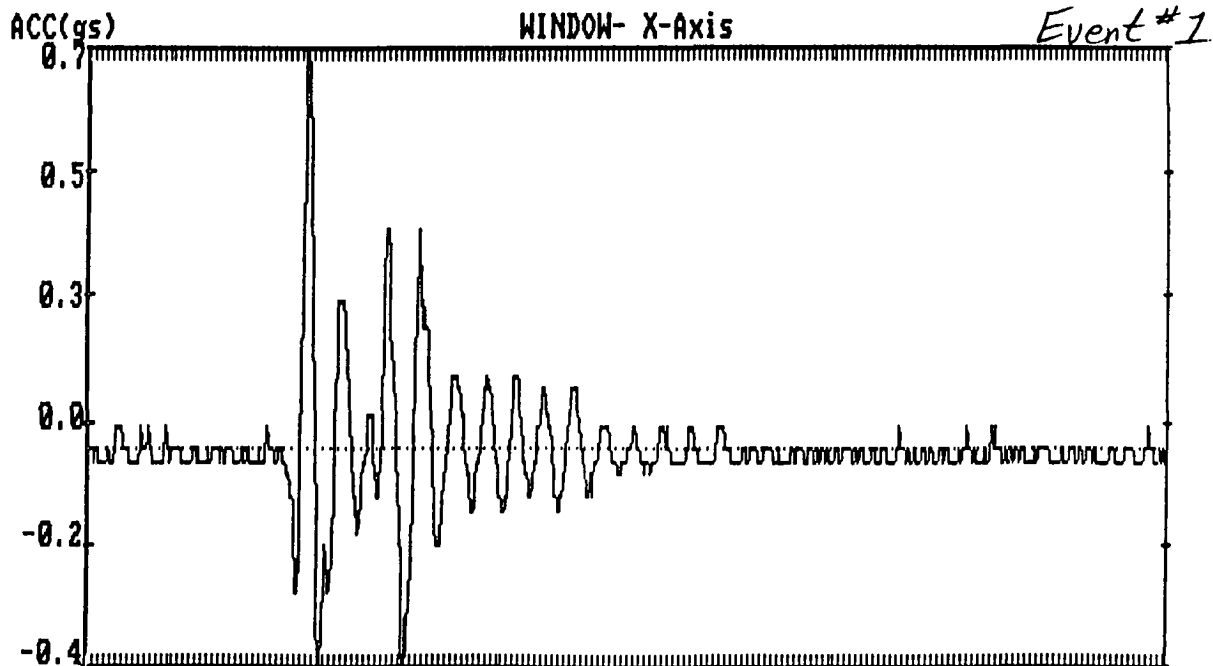
File: dec23han

File Contains 322 Temperature/Humidity Samples

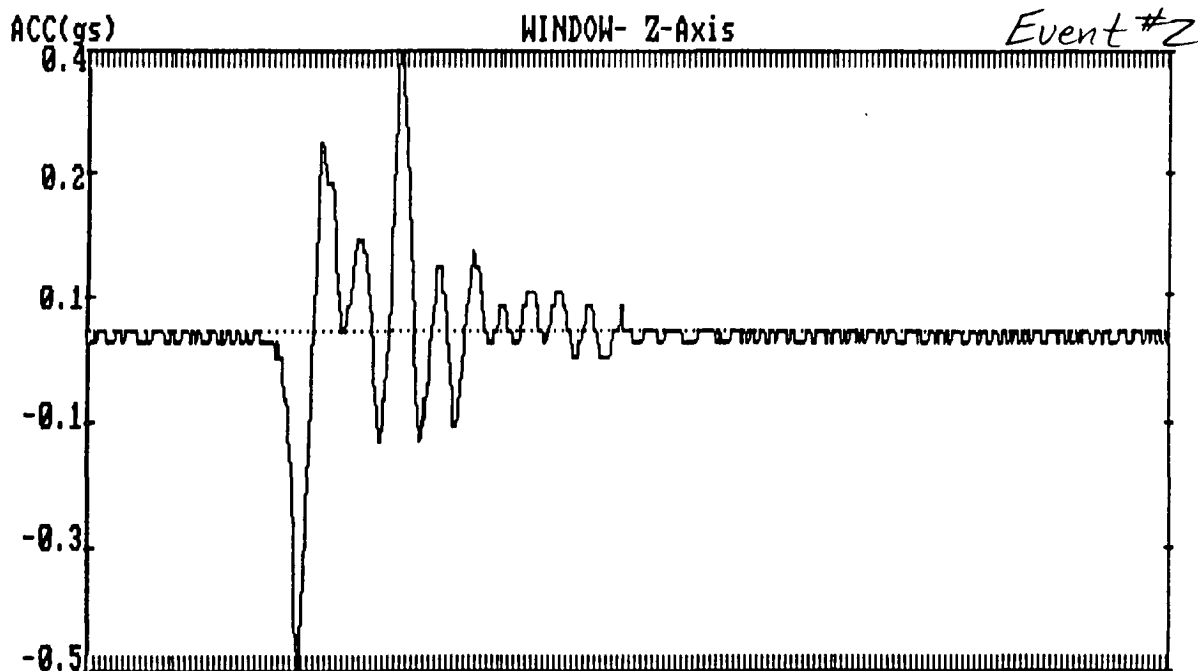
SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
309	12/29/89	02:11:15	55	53
310	12/29/89	02:41:03	54	54
311	12/29/89	03:10:52	54	55
312	12/29/89	03:40:40	54	55
313	12/29/89	04:10:29	52	56
314	12/29/89	04:40:18	52	57
315	12/29/89	05:10:06	52	56
316	12/29/89	05:39:55	51	56
317	12/29/89	06:09:43	51	57
318	12/29/89	06:39:32	51	59
319	12/29/89	07:09:21	51	60
320	12/29/89	07:39:09	51	61
321	12/29/89	08:08:58	50	63
322	12/29/89	08:38:46	50	67



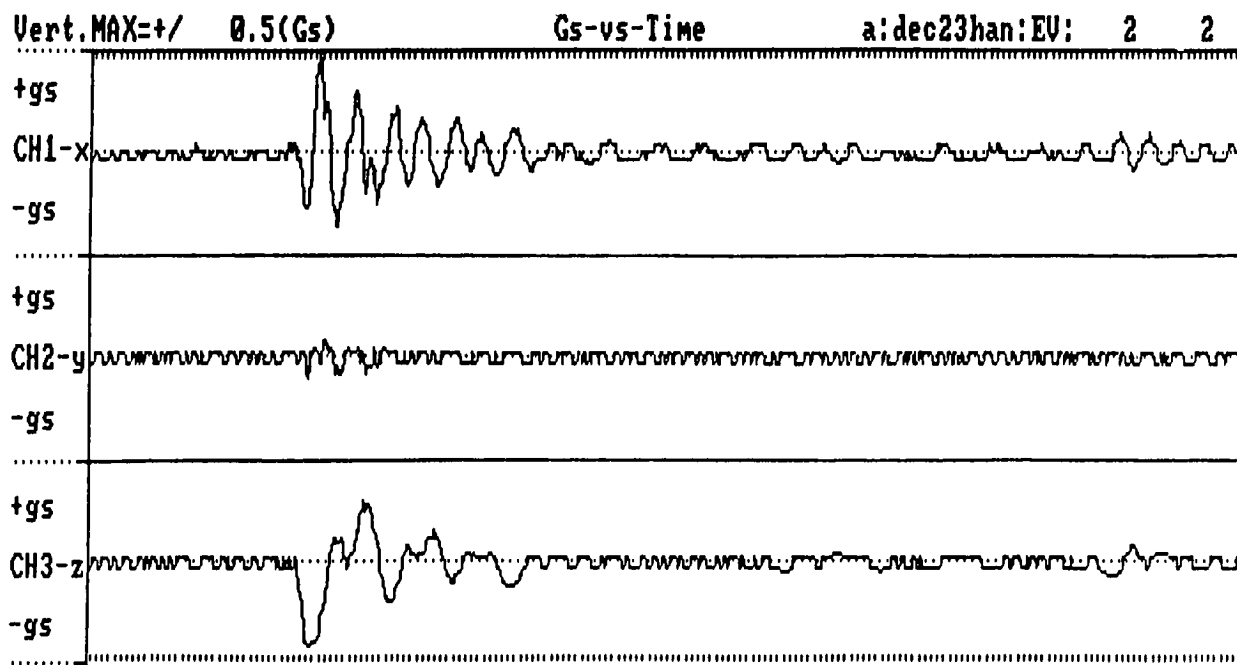
-----TIME(msec)----- [ 26.67msec/div 5000totl  
PNT/EXP: CH1-(F1/F4) 2-(F2/F5) 3-(F3/F6) DMP:F7/F8/F9 Quit-(Esc)



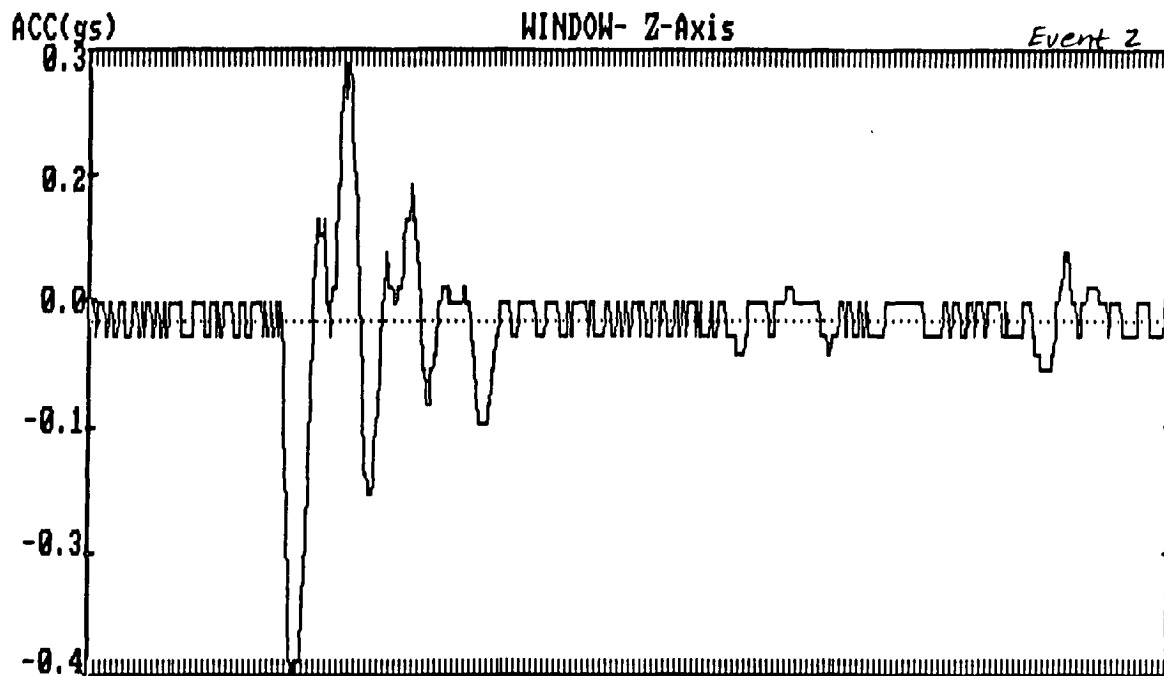
L-P1: 1 A1: 0.00Gs Delta-TIME: 0.00 msec [ 26.67msec/div 5000tot]  
R-P2: 1 A2: 0.00Gs Delta-VEL: 0.0 in/sec



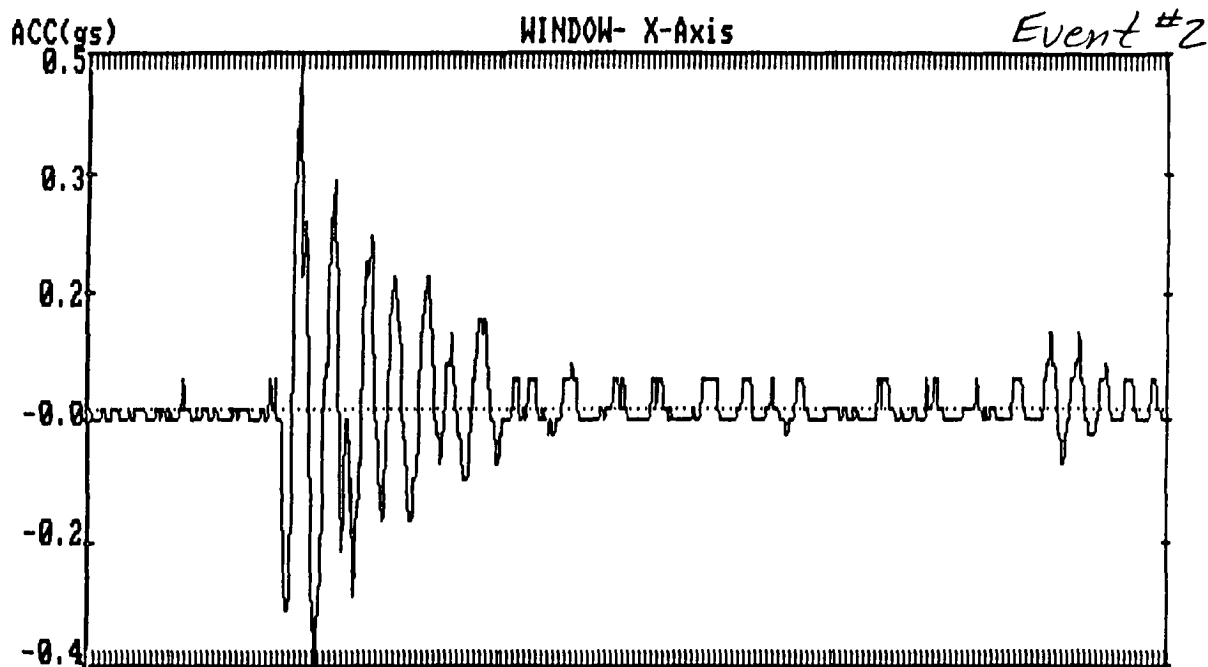
L-P1: 1 A1: -0.02Gs Delta-TIME: 0.00 msec [ 26.67msec/div 5000tot]  
R-P2: 1 A2: -0.02Gs Delta-VEL: 0.0 in/sec



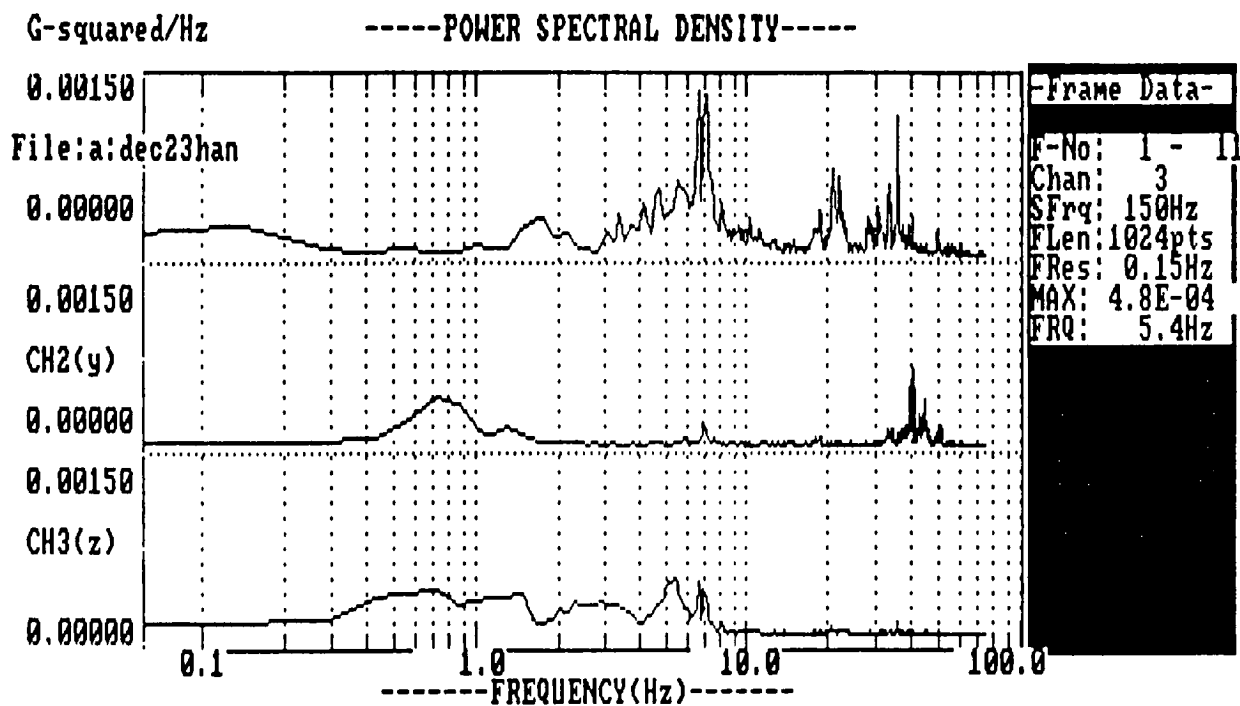
-----TIME(msec)----- [ 26.67msec/div 5000tot]  
PNT/EXP: CH1-<F1/F4> 2-<F2/F5> 3-<F3/F6> DMP:F7/F8/F9 Quit-<Esc>



L-P1: 1 A1: -0.02Gs Delta-TIME: 0.00 msec [ 26.67msec/div 5000tot]  
R-P2: 1 A2: -0.02Gs Delta-VEL: 0.0 in/sec



L-P1: 1 A1: -0.02Gs Delta-TIME: 0.00 msec [ 26.67msec/div 5000tot]  
R-P2: 1 A2: -0.02Gs Delta-VEL: 0.0 in/sec



F1-ch1 F2-ch2 F3-ch3 F4-all F5-point <Crs-Rt/Lf>-Next Frame <Esc>-Exit

Appendix C  
T-53 Testing Data

REVISION \_\_\_\_\_

90722-2.4

DOC NO.	TWR-50218	VOL
SEC	PAGE	C-1

## Appendix C

### T-53 Testing Data

2 May 1990 Testing at T-53 Vibration Test facility at Thiokol

The test procedure for the EDR-3 testing on 2 May 1990 consisted of shocking the EDR-3 with 2 g calibrated shock pulses at different temperatures. Starting at ambient, the EDR-3 was conditioned down to -42°F, and then allowed to warm to ambient, and finally conditioned to 142°F. The induced 2 g shocks were above the 1.5 g trigger level. The EDR-3 did record every 2 g input without exception.

<u>Page</u>	<u>Description</u>
C-4	EDR-3 Recording Unit Documentation report. This report contains user information, shipper information, and vibration recording parameters.
C-5	Top-EDR-3 Recording Unit Statistical Summary report. This report summarizes the maximum, minimum, and mean recorded values of temperature, humidity, vibration.
C-5	Bottom-Time Versus Temperature and Humidity Plot
C-6	Triggered Events - Vibration Frame report. This report shows that there were 37 triggered events during this portion of testing (1.5 g trigger level).
C-7 through C-10	Temperature Data - Temperature/Humidity report. This report shows the temperature and humidity values recorded throughout the test. During this test, the EDR-3 was programed to take these measurements every 2 minutes.
C-11, C-13, C-15, C-17, C-19, and C-21 through C-31	Acceleration (g) versus time plots for selected events at a C-19, variety of temperatures. The top portion of each page is the EDR-3 measured values. On each plot is the recorded temperate at the time of the event. The lower portion of each page is the T-53 response plot which represents the input shock wave that the EDR-3 recorded.
C-12, C-14, C-16, C-18, and C-20	Selected data reprocessed with corrected cold temperature calibration cure. See improved percent error calculations below in the far right column. (All recorded vibration/shock data throughout the entire temperature range is within the $\pm 10\%$ error tolerance.)

The following is a data summary of pages C-11 through C-31 including temperature and percent error calculations.

<u>Page</u>	<u>Temperature (°F)</u>	<u>T-53 Input</u>	<u>EDR-3 Measure (g)</u>	<u>Percent Error</u>	<u>EDR-3 Measure (g)*</u>	<u>Percent Error*</u>
C-11, C-12	-38	2.02	2.28	12.9	2.02	0
C-13, C-14	-42	2.02	2.28	12.9	2.02	0
C-15, C-16	-41	1.97	2.30	16.8	2.04	-3.55
C-17, C-18	-22	2.00	2.20	10.0	1.98	-1.0
C-19, C-20	-16	2.00	1.16	8.0	1.96	-2.0
C-21	-10	2.06	1.96	-4.9		
C-22	-5	2.00	1.96	-2.0		
C-23	12	1.89	1.90	0.5		
C-24	33	1.82	1.88	3.3		
C-25	65	1.82	1.88	3.3		
C-26	101	2.17	2.14	-1.4		
C-27	121	2.17	2.12	2.3		
C-28	127	2.15	2.18	1.4		
C-29	131	2.13	2.18	2.3		
C-30	142	2.19	2.18	-0.5		
C-31	142	2.15	2.18	1.4		

\*EDR-3 measured response and percent error calculations for cold temperatures testing after processing the same data with an improved temperature calibration curve. The new calibration curve did not change the recorded levels on pages C-21 through C-31

Environmental Data Recorder: USER DOCUMENTATION

Report Date: 05-02-1990

Report Ident: Unit #4, EDR-3 Evaluation Test

File: t53m24

Recording Start Date: 05/02/90  
Time: 11:22:31

Recording End Date: 05/02/90  
Time: 16:20:41

FILENAME: t53m24

USER ID: Kevin Rees

ORIGIN:

DESTINATION:

SHIPPER:  
CARRIER:  
MODE:

COMMENTS: Test per ETP-0539A

RECORDING CONTROL PARAMETERS

SAMPLE FREQUENCY(Hz): 200  
TRIGGER LEVEL(gs): 1.5

TRIGGER DURATION THRESHOLD: 3  
PRE-TRIGGER SAMPLES: 50  
POST-TRIGGER SAMPLES: 50  
CHANNEL SELECT--: (0=(PR-int), 1=(PE-ext) ) 0

MEMORY MODE----: (0=fill&stop 1=overwrite) 1  
MAXIMUM No. EVENTS: (MEM MODE 1=req. for PSDs) 400

TIME-TRIG DELAY: (min seconds between EVs) 0  
MAXIMUM EV LENGTH: 2047

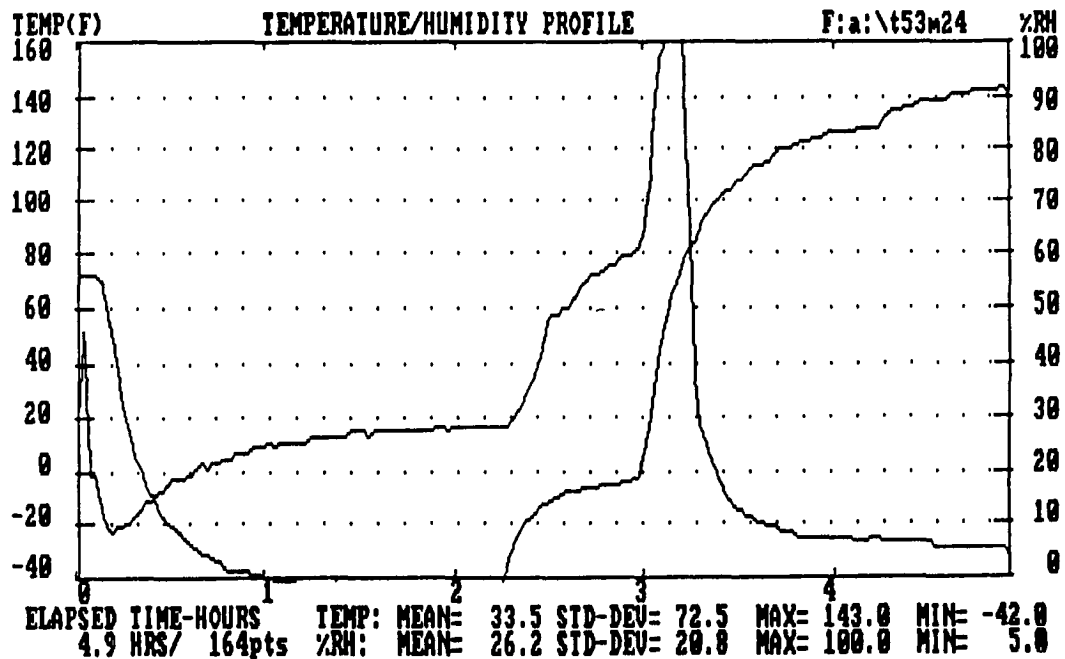
Environmental Data Recorder: STATISTICAL SUMMARY REPORT  
Report Date: 05-23-1990  
Report Ident: Unit #4, EDR-3 Evaluation Test

File: t53m24

File Contains 37 Acceleration Frames

		ACCELERATION STATISTICS					
		--Channel-1(x)----		Channel-2(y)----		Channel-3(z)----	
Peak Accel. G-Levels	max.....	2.33/	-1.33	0.32/	-0.31	0.14/	-0.13
	min.....	1.80/	-0.95	0.14/	-0.14	0.06/	-0.07
	mean.....	2.10/	-1.08	0.21/	-0.19	0.10/	-0.10
	std-dev....	0.15/	0.08	0.04/	0.04	0.03/	0.01
RMS G Levels	max.....	0.59	...	0.07	...	0.04	...
	min.....	0.47	...	0.04	...	0.02	...
	mean.....	0.54	...	0.05	...	0.03	...
	std-dev....	0.04	...	0.01	...	0.00	...
Crest Factor	max.....	4.03	...	5.02	...	4.25	...
	min.....	3.42	...	3.31	...	2.60	...
	mean.....	3.89	...	3.99	...	3.60	...
	std-dev....	0.10	...	0.39	...	0.38	...

		-TEMPERATURE---		%RELATIVE HUMIDITY-	
max.....	143.00	...	100.00	...	
min.....	-42.00	...	5.00	...	
mean.....	33.51	...	26.24	...	
std-dev....	72.51	...	20.76	...	



VIBRATION FRAME REPORT

Report Date: 05-02-1990

Report Ident: Unit #4, EDR-3 Evaluation Test

File: t53m24

Temperatures (F)

File Contains 37 Acceleration Frames

No.	Date	Time	Peak G levels						RMS levels			Crest Factors		
			+ 1-x -	+ 2-y -	+ 3-z -	1-x	2-y	3-z	1-x	2-y	3-z	1-x	2-y	3-z
105/02/90	11:37:31	202.0/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	4.0	5.0	3.5			
205/02/90	11:41:17	52.1/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	4.0	4.4	3.3			
305/02/90	11:45:01	62.1/	1.1	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	4.0	3.8	3.2			
405/02/90	11:53:07	201.8/	1.2	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.4	3.3	3.5			
505/02/90	12:02:31	301.8/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	3.8	4.1	3.7			
605/02/90	12:14:02	371.9/	1.3	0.2/ 0.3	0.1/ 0.1	0.5	0.1	0.0	3.6	4.7	3.8			
705/02/90	12:19:52	382.3/	1.2	0.3/ 0.3	0.1/ 0.1	0.6	0.1	0.0	3.9	4.3	3.3			
805/02/90	12:27:17	402.3/	1.2	0.3/ 0.3	0.1/ 0.1	0.6	0.1	0.0	3.9	3.6	3.5			
905/02/90	12:44:16	402.3/	1.2	0.3/ 0.2	0.1/ 0.1	0.6	0.1	0.0	3.9	3.7	3.6			
1005/02/90	12:55:41	422.3/	1.2	0.3/ 0.3	0.1/ 0.1	0.6	0.1	0.0	3.9	3.5	3.4			
1105/02/90	13:13:50	422.2/	1.2	0.3/ 0.2	0.1/ 0.1	0.6	0.1	0.0	3.8	4.3	2.6			
1205/02/90	13:26:56	422.3/	1.2	0.3/ 0.3	0.1/ 0.1	0.6	0.1	0.0	3.9	3.6	3.7			
1305/02/90	13:34:42	412.3/	1.2	0.3/ 0.3	0.1/ 0.1	0.6	0.1	0.0	3.9	4.0	3.6			
1405/02/90	13:42:27	422.2/	1.2	0.3/ 0.2	0.1/ 0.1	0.6	0.1	0.0	3.9	4.0	3.5			
1505/02/90	13:47:41	462.2/	1.1	0.3/ 0.2	0.1/ 0.1	0.6	0.1	0.0	3.9	4.1	2.6			
1605/02/90	13:53:06	402.0/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.9	3.6	3.9			
1705/02/90	13:57:21	82.0/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.9	3.7	3.5			
1805/02/90	14:06:11	52.0/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.9	3.7	3.7			
1905/02/90	14:10:31	41.9/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.8	4.5	3.8			
2005/02/90	14:14:36	42.0/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.9	3.8	3.5			
2105/02/90	14:23:41	121.9/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.1	0.0	3.9	4.0	3.7			
2205/02/90	14:26:30	331.9/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	3.9	3.4	3.8			
2305/02/90	14:29:13	521.9/	1.0	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	3.9	4.1	4.0			
2405/02/90	14:31:50	651.9/	0.9	0.2/ 0.2	0.1/ 0.1	0.5	0.0	0.0	4.0	3.8	4.1			
2505/02/90	14:37:46	822.1/	1.1	0.2/ 0.2	0.1/ 0.1	0.6	0.1	0.0	3.8	3.9	3.5			
2605/02/90	14:47:26	1012.1/	1.0	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	3.9	3.2			
2705/02/90	14:55:46	1112.2/	1.1	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.4	3.9			
2805/02/90	15:09:11	1212.1/	1.0	0.1/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	3.7	4.0			
2905/02/90	15:18:01	1242.2/	1.0	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.3	4.3			
3005/02/90	15:28:26	1272.2/	1.1	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.4	3.2			
3105/02/90	15:39:16	1312.2/	1.1	0.1/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	3.7	4.1			
3205/02/90	15:49:56	1372.2/	1.0	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.5	4.0			
3305/02/90	15:54:31	1382.1/	1.0	0.2/ 0.1	0.1/ 0.1	0.6	0.0	0.0	3.9	3.8	4.0			
3405/02/90	16:01:51	1412.2/	1.0	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.5	4.0			
3505/02/90	16:05:17	1412.2/	1.0	0.2/ 0.1	0.1/ 0.1	0.6	0.0	0.0	3.9	3.7	3.2			
3605/02/90	16:11:06	1422.2/	1.0	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	3.7	3.9			
3705/02/90	16:14:31	1422.2/	1.1	0.2/ 0.2	0.1/ 0.1	0.6	0.0	0.0	3.9	4.4	3.1			

↑  
°F

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-02-1990  
Report Ident: Unit #4, EDR-3 Evaluation

File: t53m24

File Contains 164 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL. HUMIDITY
1	05/02/90	11:22:31	73	31
2	05/02/90	11:24:20	73	46
3	05/02/90	11:26:09	73	20
4	05/02/90	11:27:58	73	20
5	05/02/90	11:29:48	70	13
6	05/02/90	11:31:37	60	10
7	05/02/90	11:33:26	49	9
8	05/02/90	11:35:15	37	10
9	05/02/90	11:37:04	25	10
10	05/02/90	11:38:54	15	11
11	05/02/90	11:40:43	7	12
12	05/02/90	11:42:32	2	13
13	05/02/90	11:44:21	-4	15
14	05/02/90	11:46:11	-8	15
15	05/02/90	11:48:00	-13	16
16	05/02/90	11:49:49	-16	17
17	05/02/90	11:51:38	-19	18
18	05/02/90	11:53:27	-20	19
19	05/02/90	11:55:17	-22	19
20	05/02/90	11:57:06	-25	19
21	05/02/90	11:58:55	-27	20
22	05/02/90	12:00:44	-28	21
23	05/02/90	12:02:34	-30	22
24	05/02/90	12:04:23	-31	21
25	05/02/90	12:06:12	-32	22
26	05/02/90	12:08:01	-33	22
27	05/02/90	12:09:50	-35	23
28	05/02/90	12:11:40	-36	23
29	05/02/90	12:13:29	-36	24
30	05/02/90	12:15:18	-37	24
31	05/02/90	12:17:07	-37	24
32	05/02/90	12:18:57	-38	25
33	05/02/90	12:20:46	-38	25
34	05/02/90	12:22:35	-39	25
35	05/02/90	12:24:24	-39	26
36	05/02/90	12:26:14	-40	25
37	05/02/90	12:28:03	-40	26
38	05/02/90	12:29:52	-40	26
39	05/02/90	12:31:41	-40	26
40	05/02/90	12:33:30	-41	26
41	05/02/90	12:35:20	-41	26
42	05/02/90	12:37:09	-41	27
43	05/02/90	12:38:58	-41	27
44	05/02/90	12:40:47	-41	27

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-02-1990  
Report Ident: Unit #4, EDR-3 Evaluation

File: t53m24

File Contains 164 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
45	05/02/90	12:42:37	-41	27
46	05/02/90	12:44:26	-40	27
47	05/02/90	12:46:15	-42	27
48	05/02/90	12:48:04	-42	27
49	05/02/90	12:49:53	-42	28
50	05/02/90	12:51:43	-41	28
51	05/02/90	12:53:32	-41	28
52	05/02/90	12:55:21	-42	27
53	05/02/90	12:57:10	-41	28
54	05/02/90	12:59:00	-42	28
55	05/02/90	13:00:49	-41	28
56	05/02/90	13:02:38	-41	28
57	05/02/90	13:04:27	-41	28
58	05/02/90	13:06:17	-41	28
59	05/02/90	13:08:06	-41	28
60	05/02/90	13:09:55	-42	28
61	05/02/90	13:11:44	-42	28
62	05/02/90	13:13:33	-42	28
63	05/02/90	13:15:23	-41	28
64	05/02/90	13:17:12	-41	29
65	05/02/90	13:19:01	-42	29
66	05/02/90	13:20:50	-41	28
67	05/02/90	13:22:40	-42	29
68	05/02/90	13:24:29	-41	29
69	05/02/90	13:26:18	-42	29
70	05/02/90	13:28:07	-42	29
71	05/02/90	13:29:56	-42	29
72	05/02/90	13:31:46	-42	29
73	05/02/90	13:33:35	-41	29
74	05/02/90	13:35:24	-41	29
75	05/02/90	13:37:13	-41	29
76	05/02/90	13:39:03	-32	29
77	05/02/90	13:40:52	-27	30
78	05/02/90	13:42:41	-22	32
79	05/02/90	13:44:30	-19	34
80	05/02/90	13:46:19	-17	36
81	05/02/90	13:48:09	-15	39
82	05/02/90	13:49:58	-13	42
83	05/02/90	13:51:47	-11	48
84	05/02/90	13:53:36	-10	49
85	05/02/90	13:55:26	-9	49
86	05/02/90	13:57:15	-8	50
87	05/02/90	13:59:04	-7	50
88	05/02/90	14:00:53	-7	52

Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-02-1990  
Report Ident: Unit #4, EDR-3 Evaluation

File: t53m24

File Contains 164 Temperature/Humidity Samples

SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
89	05/02/90	14:02:43	-6	54
90	05/02/90	14:04:32	-5	55
91	05/02/90	14:06:21	-5	56
92	05/02/90	14:08:10	-5	56
93	05/02/90	14:09:59	-4	57
94	05/02/90	14:11:49	-4	58
95	05/02/90	14:13:38	-4	58
96	05/02/90	14:15:27	-4	59
97	05/02/90	14:17:16	-3	60
98	05/02/90	14:19:06	-3	60
99	05/02/90	14:20:55	-2	61
100	05/02/90	14:22:44	7	64
101	05/02/90	14:24:33	18	73
102	05/02/90	14:26:22	33	87
103	05/02/90	14:28:12	46	97
104	05/02/90	14:30:01	57	100
105	05/02/90	14:31:50	65	100
106	05/02/90	14:33:39	71	100
107	05/02/90	14:35:29	78	100
108	05/02/90	14:37:18	82	61
109	05/02/90	14:39:07	85	37
110	05/02/90	14:40:56	90	29
111	05/02/90	14:42:46	94	25
112	05/02/90	14:44:35	98	22
113	05/02/90	14:46:24	100	19
114	05/02/90	14:48:13	103	17
115	05/02/90	14:50:02	104	15
116	05/02/90	14:51:52	107	14
117	05/02/90	14:53:41	109	13
118	05/02/90	14:55:30	111	12
119	05/02/90	14:57:19	113	12
120	05/02/90	14:59:09	114	11
121	05/02/90	15:00:58	115	11
122	05/02/90	15:02:47	116	10
123	05/02/90	15:04:36	118	10
124	05/02/90	15:06:25	120	9
125	05/02/90	15:08:15	120	9
126	05/02/90	15:10:04	121	9
127	05/02/90	15:11:53	122	8
128	05/02/90	15:13:42	123	8
129	05/02/90	15:15:32	123	8
130	05/02/90	15:17:21	124	8
131	05/02/90	15:19:10	124	8
132	05/02/90	15:20:59	125	8

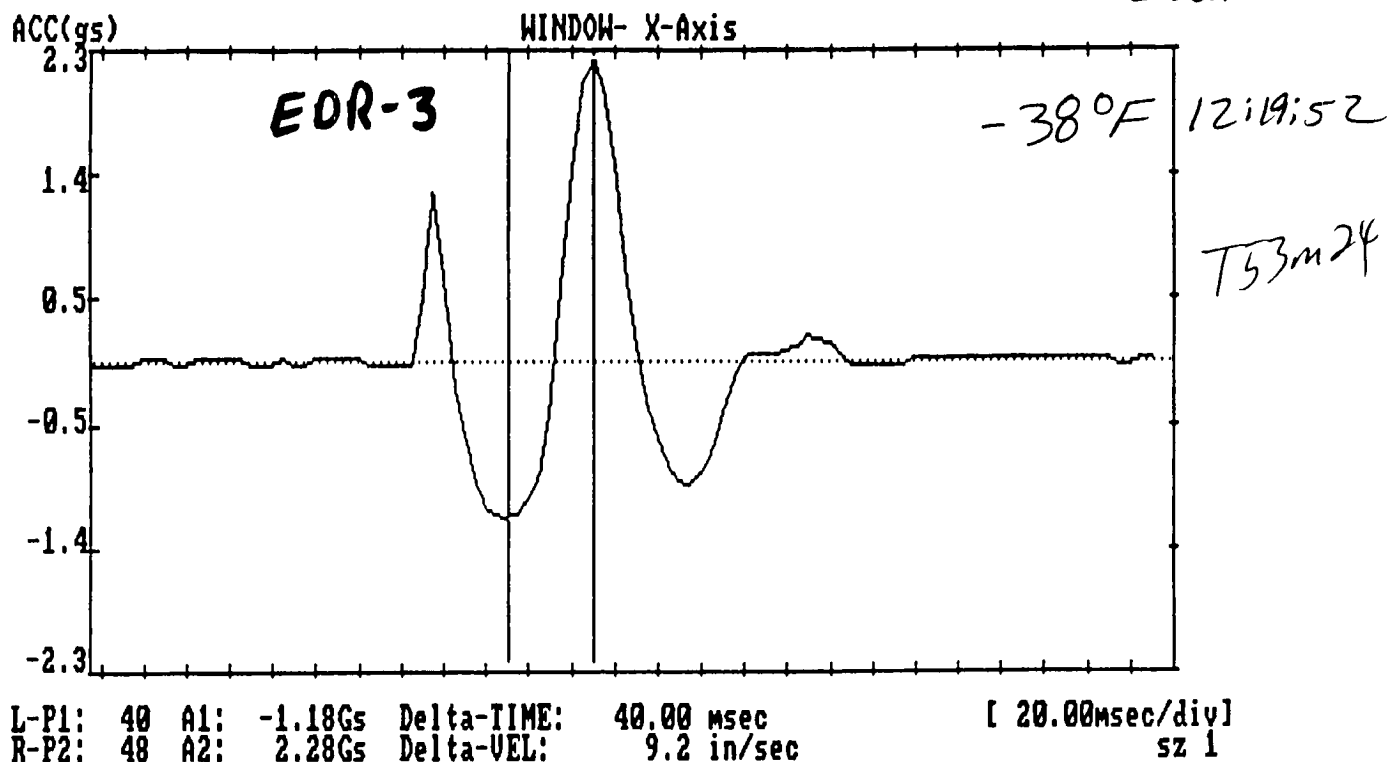
Environmental Data Recorder: TEMPERATURE/HUMIDITY REPORT  
Report Date: 05-02-1990  
Report Ident: Unit #4, EDR-3 Evaluation

File: t53m24

File Contains 164 Temperature/Humidity Samples

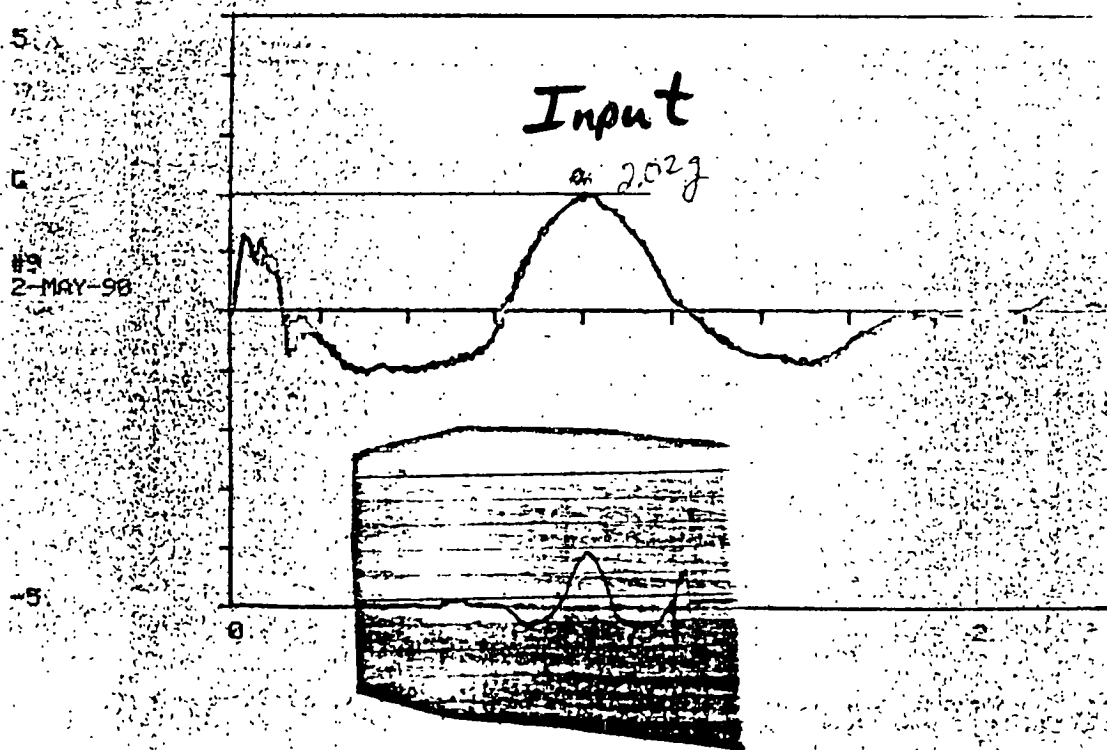
SAMPLE NO.	DATE	TIME	TEMPERATURE	%REL.HUMIDITY
133	05/02/90	15:22:49	126	8
134	05/02/90	15:24:38	126	8
135	05/02/90	15:26:27	126	8
136	05/02/90	15:28:16	127	8
137	05/02/90	15:30:05	127	7
138	05/02/90	15:31:55	128	7
139	05/02/90	15:33:44	128	7
140	05/02/90	15:35:33	128	8
141	05/02/90	15:37:22	128	8
142	05/02/90	15:39:12	131	7
143	05/02/90	15:41:01	134	7
144	05/02/90	15:42:50	135	7
145	05/02/90	15:44:39	135	7
146	05/02/90	15:46:28	136	7
147	05/02/90	15:48:18	136	7
148	05/02/90	15:50:07	137	7
149	05/02/90	15:51:56	138	7
150	05/02/90	15:53:45	138	7
151	05/02/90	15:55:35	138	6
152	05/02/90	15:57:24	139	6
153	05/02/90	15:59:13	139	6
154	05/02/90	16:01:02	141	6
155	05/02/90	16:02:52	141	6
156	05/02/90	16:04:41	141	6
157	05/02/90	16:06:30	141	6
158	05/02/90	16:08:19	142	6
159	05/02/90	16:10:08	142	6
160	05/02/90	16:11:58	142	6
161	05/02/90	16:13:47	142	6
162	05/02/90	16:15:36	142	6
163	05/02/90	16:17:25	143	6
164	05/02/90	16:19:15	139	5

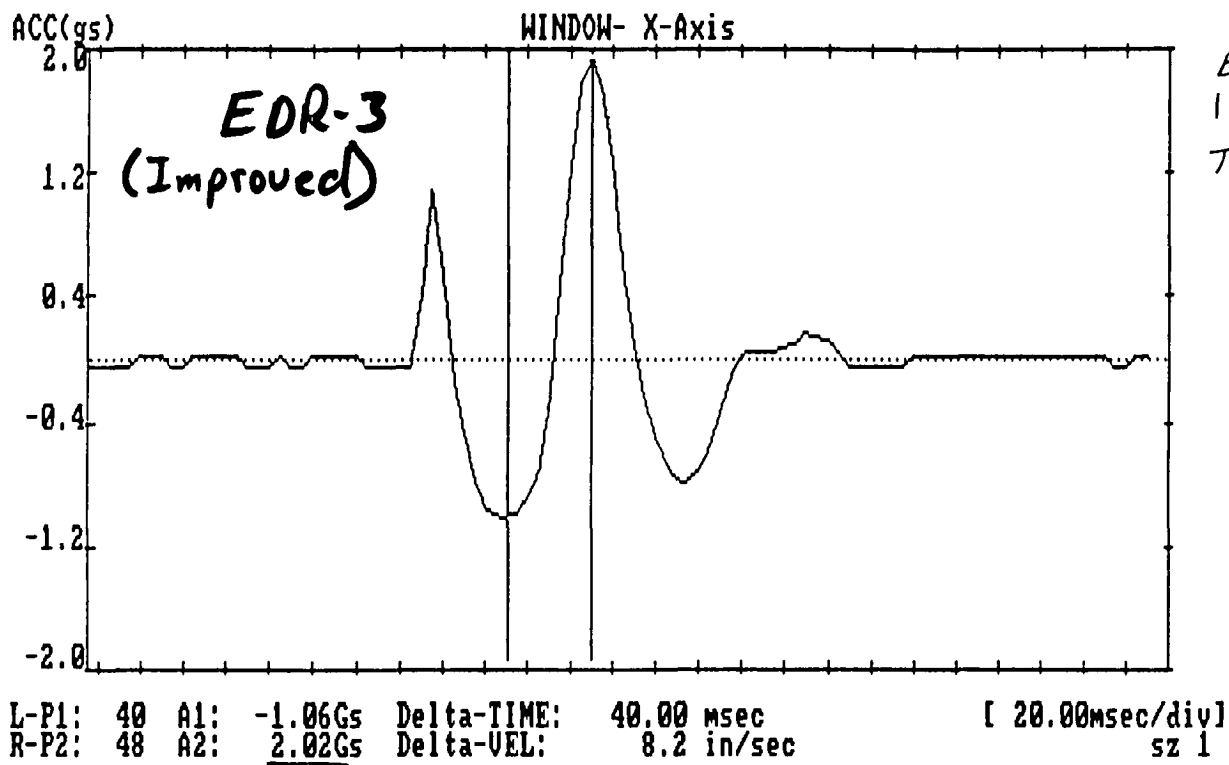
Unit 4  
Event 7



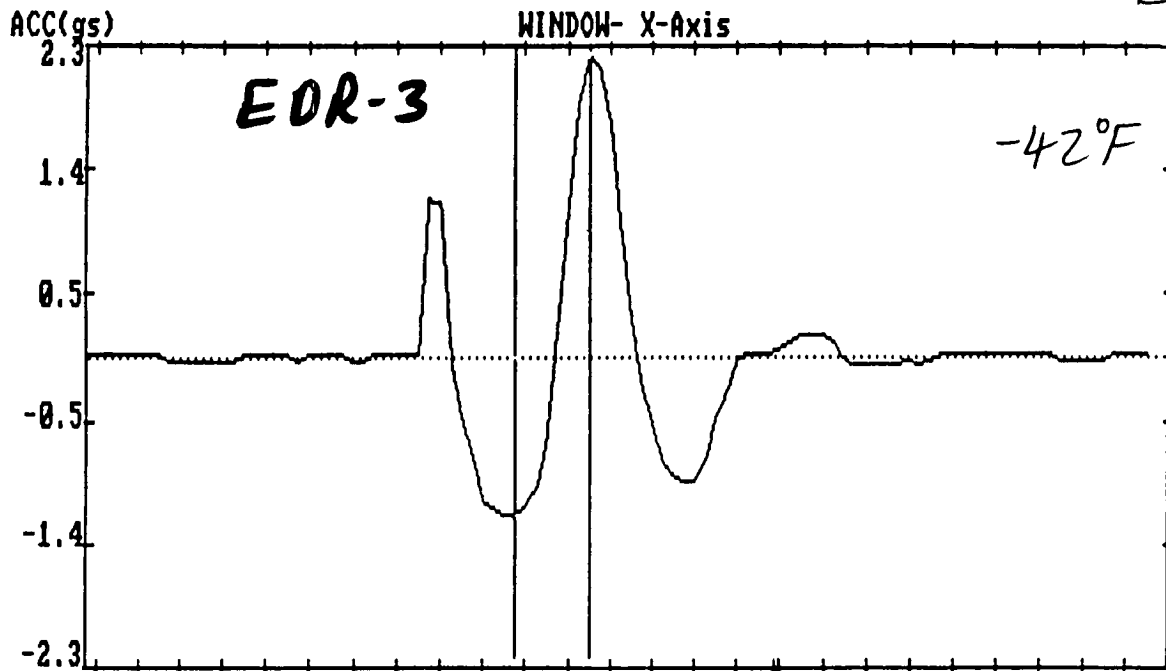
Input 2.02g

-41°F



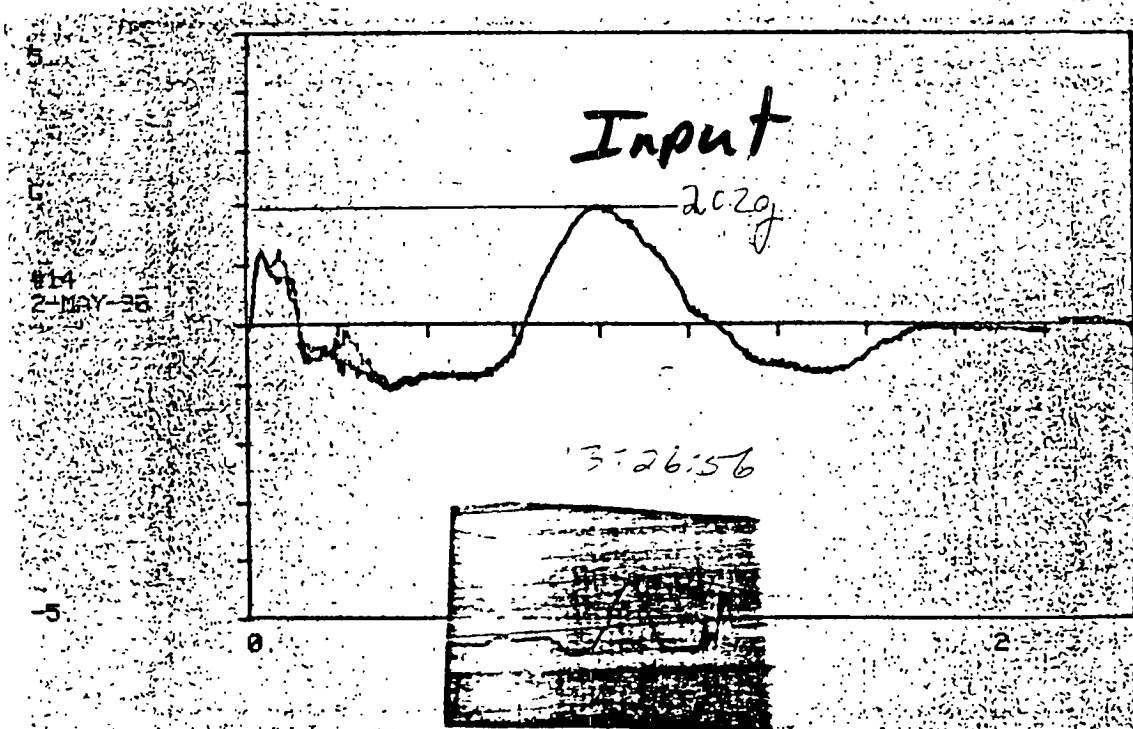


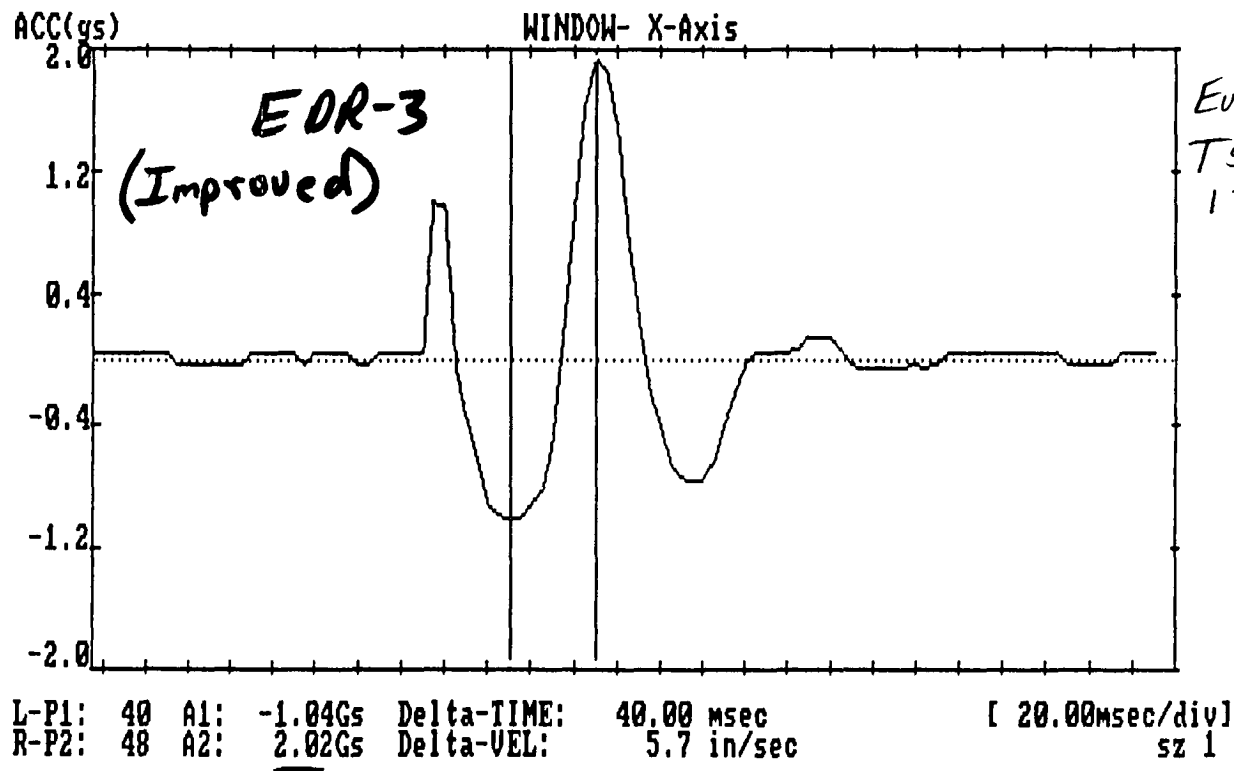
Input 2.02g



L-P1: 41 A1: -1.18Gs Delta-TIME: 35.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 2.28Gs Delta-VEL: 8.8 in/sec sz 1

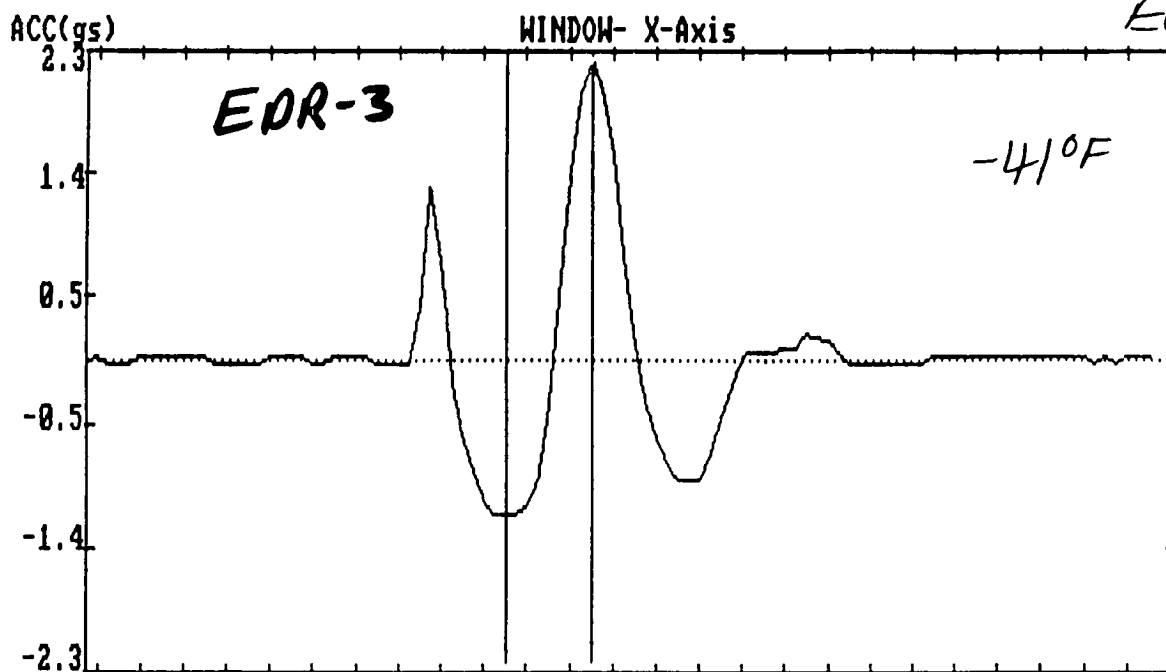
Input 2.02g



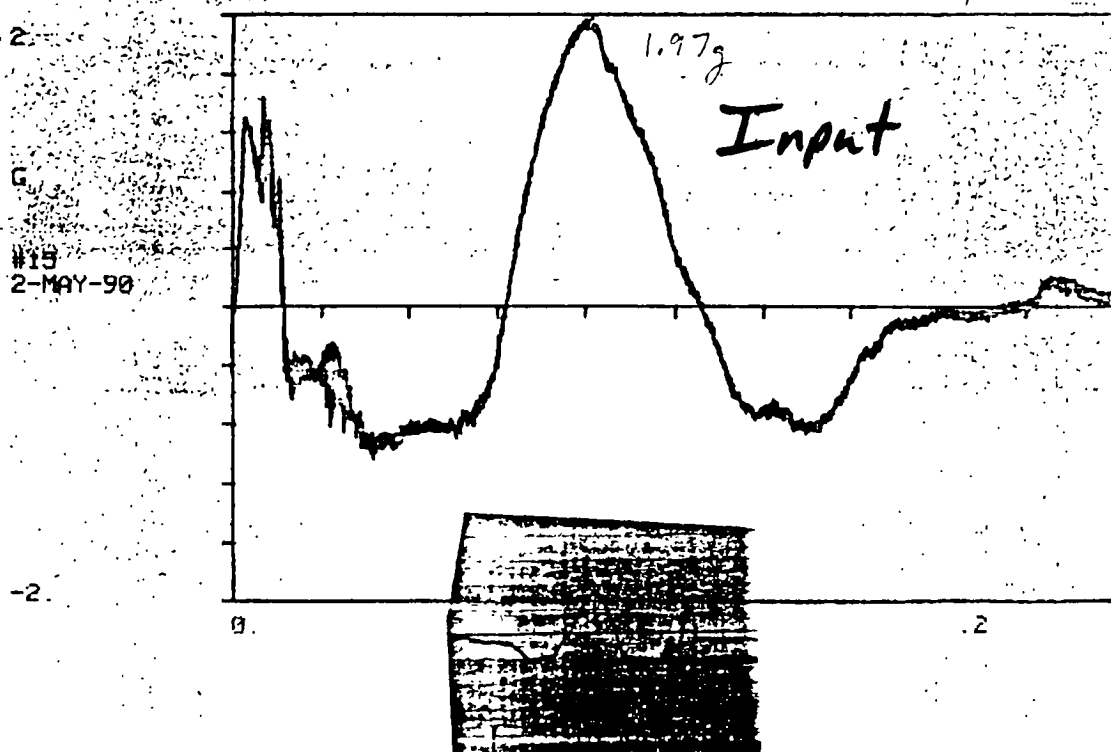


Input 2.02

Unit 4  
Event 13



L-P1: 40 A1: -1.18Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 2.30Gs Delta-VEL: 8.6 in/sec sz 1

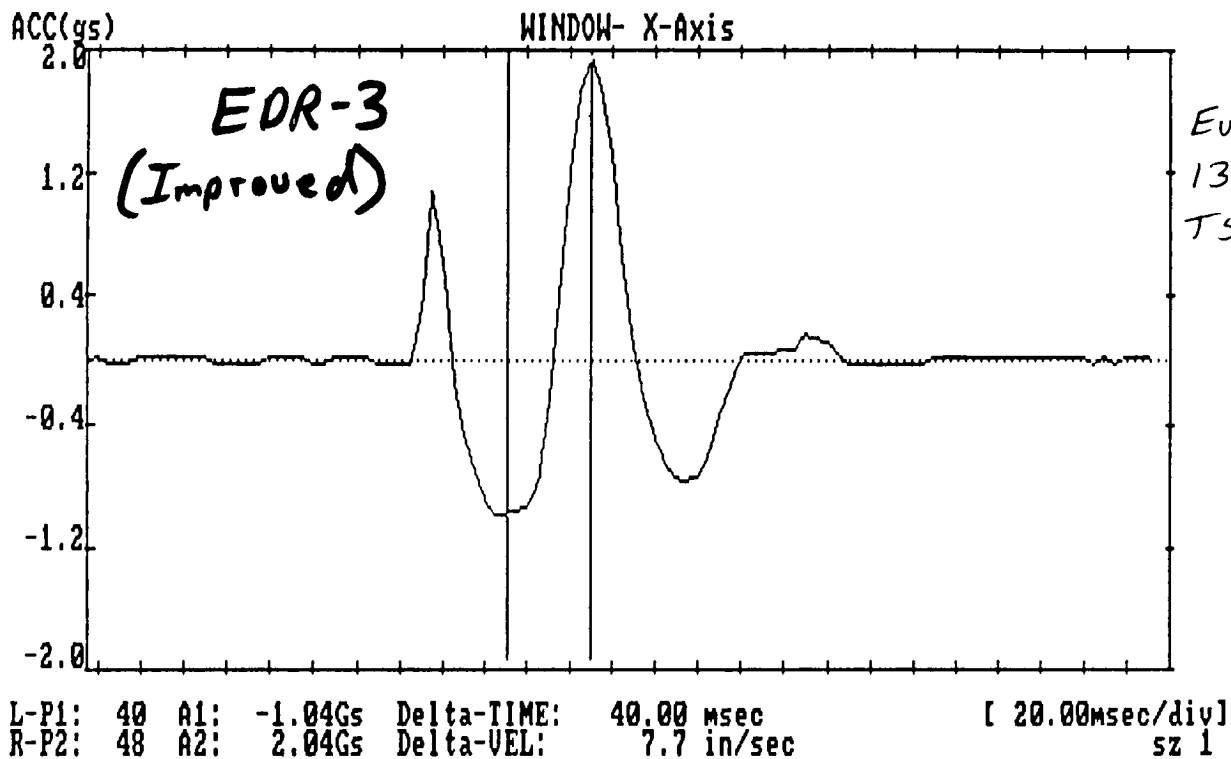


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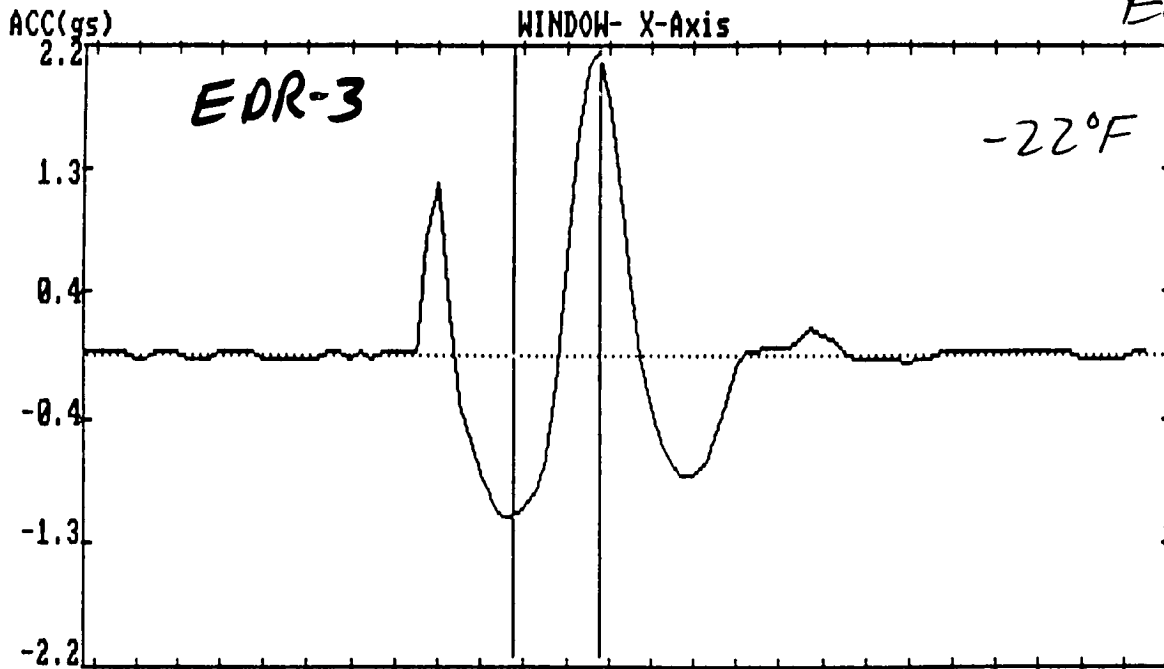
DOC NO TWR-50218 VOL  
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Input 1.97g

Unit 4  
Event 14

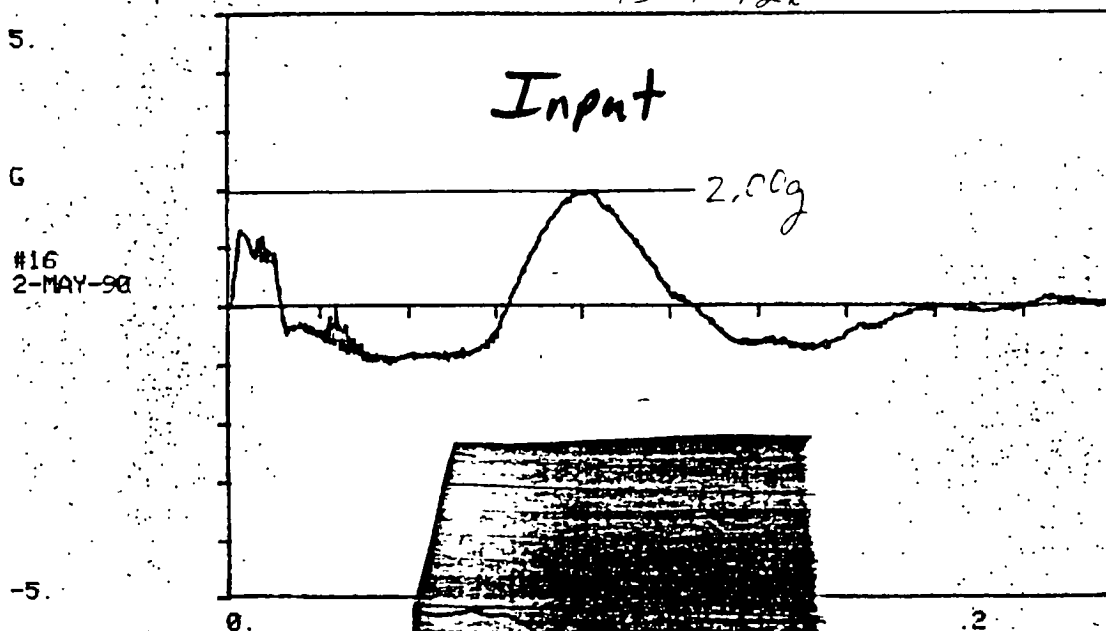


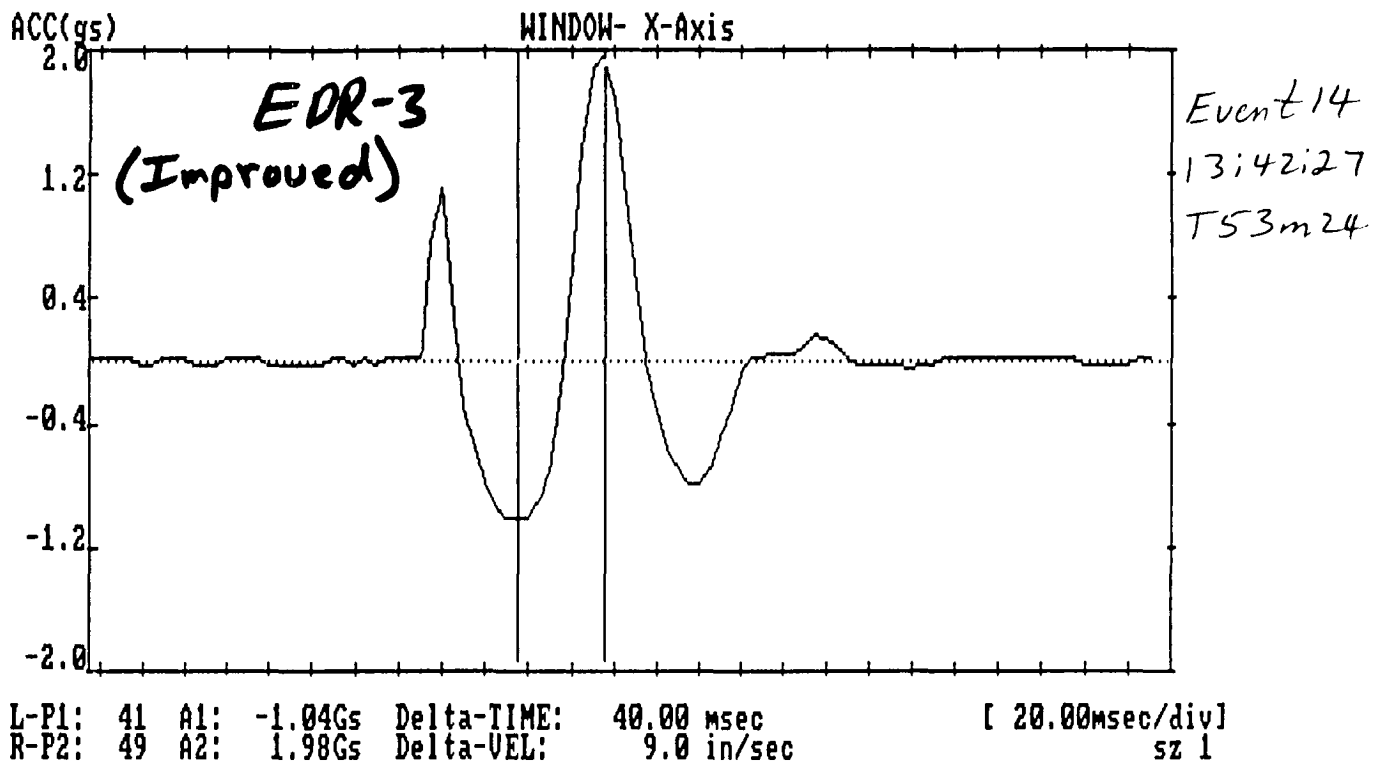
L-P1: 41 A1: -1.16Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 49 A2: 2.20Gs Delta-VEL: 10.0 in/sec sz 1

Input 2.0g

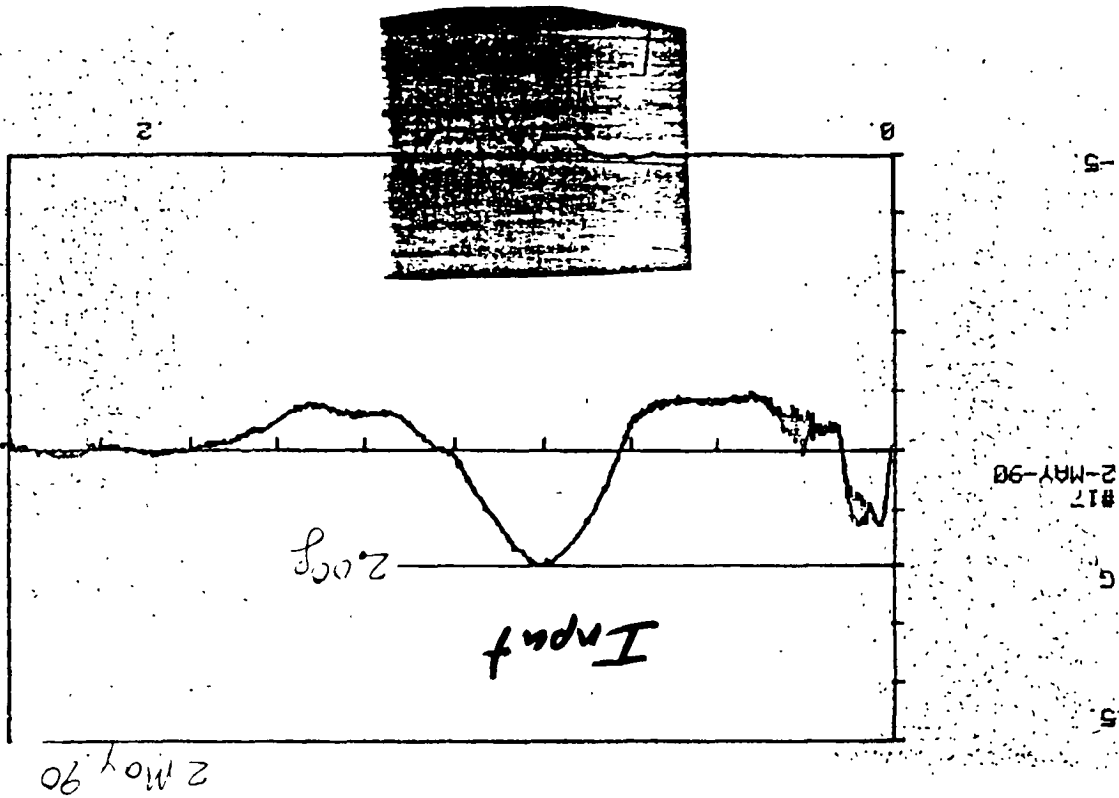
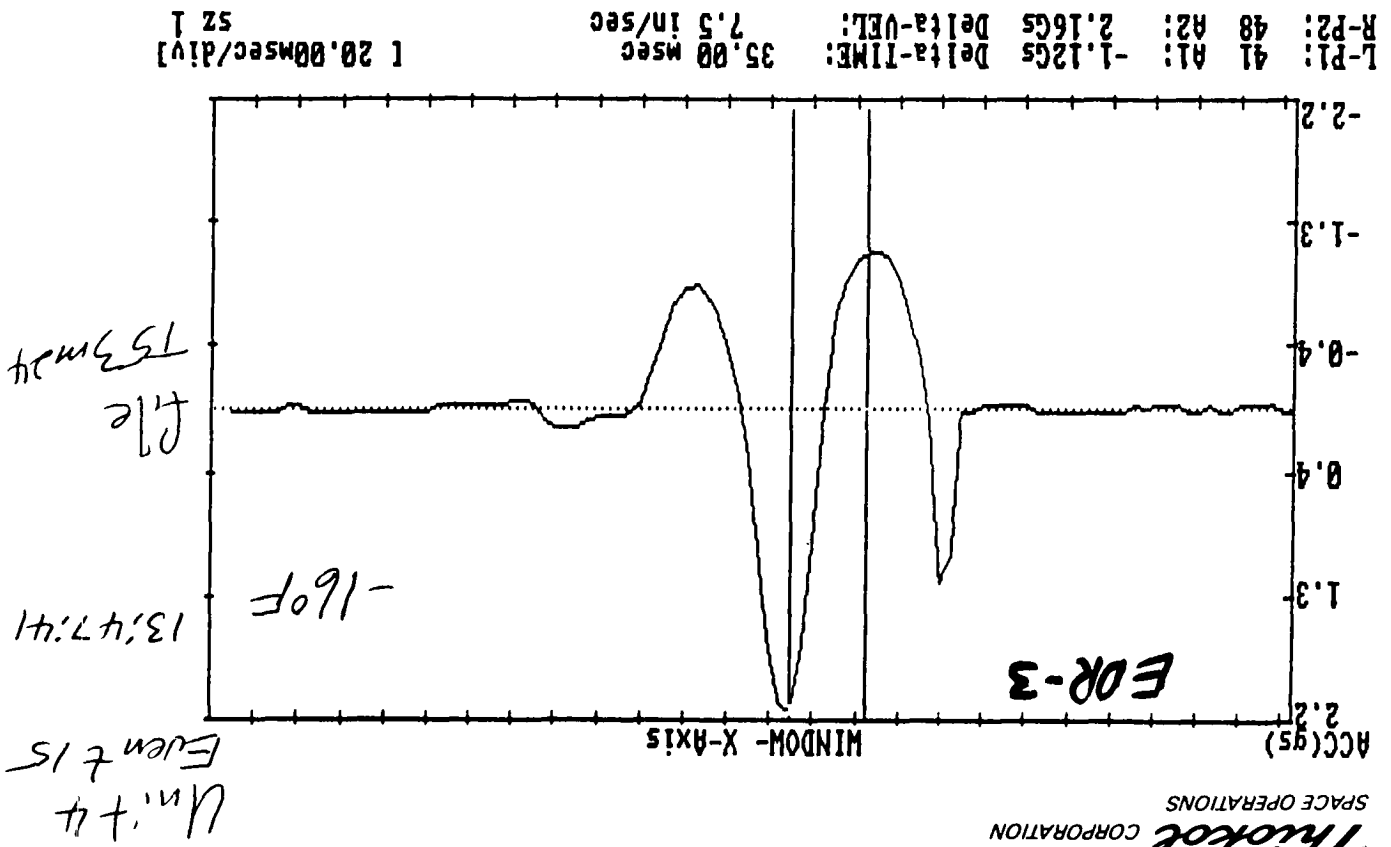
13:42:26

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Input 2.0g



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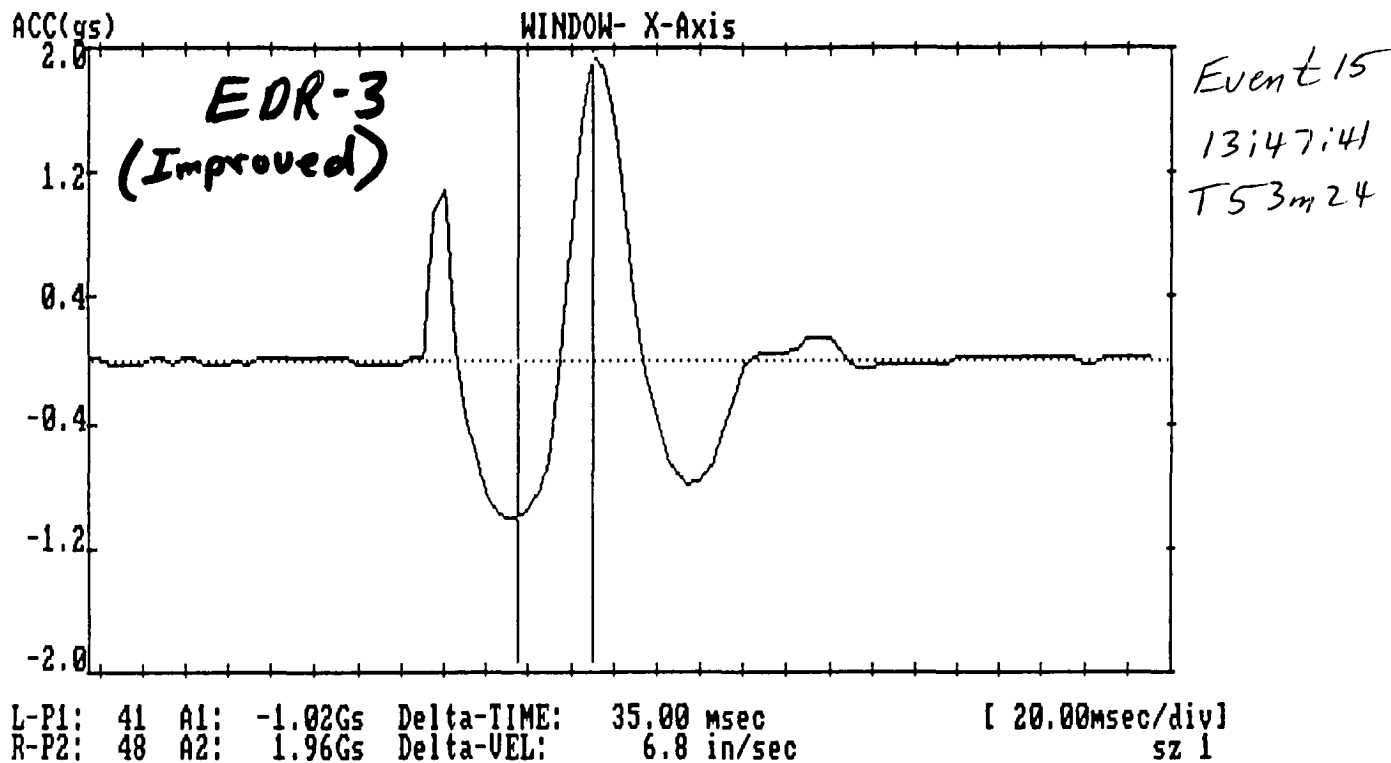
DOC NO

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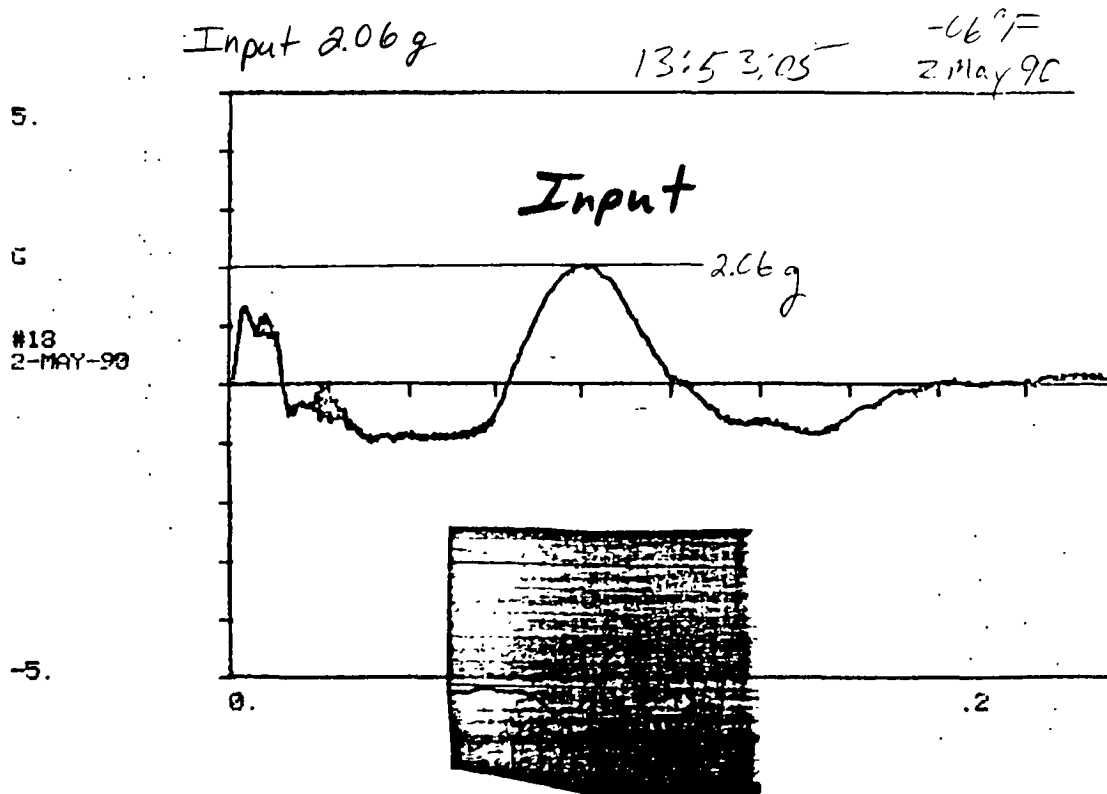
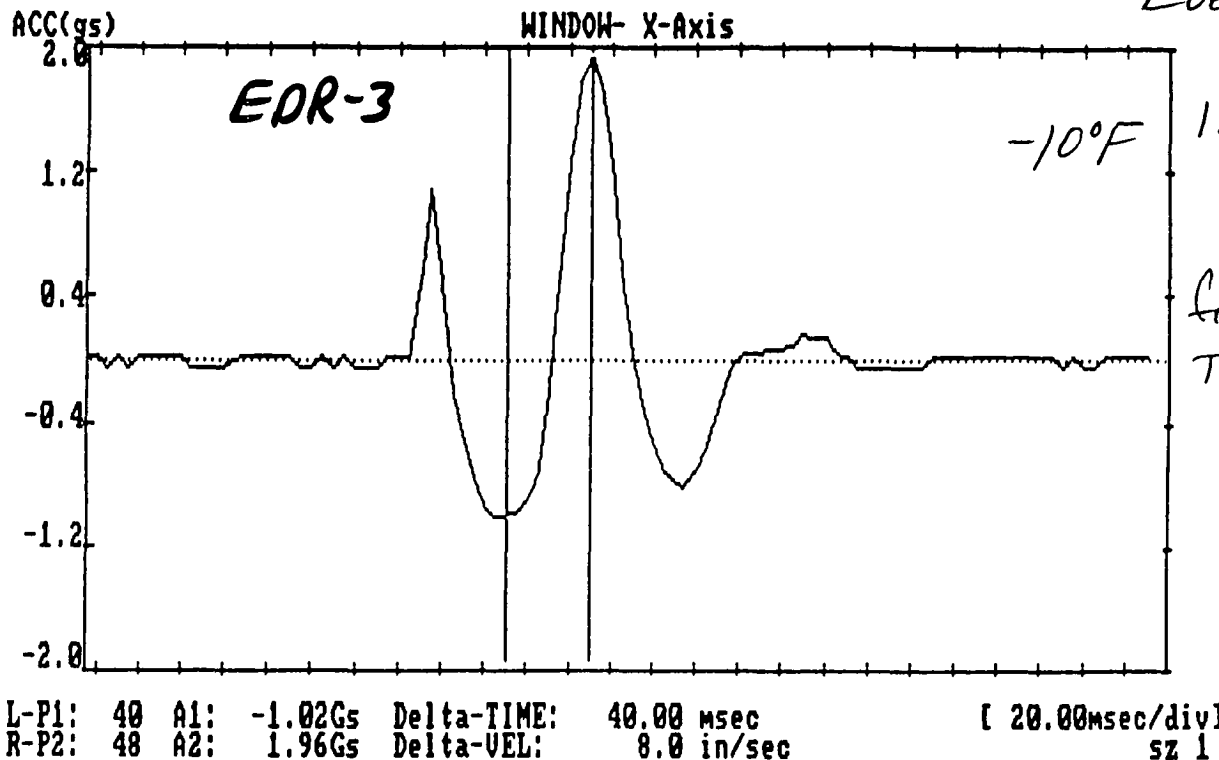
VOL

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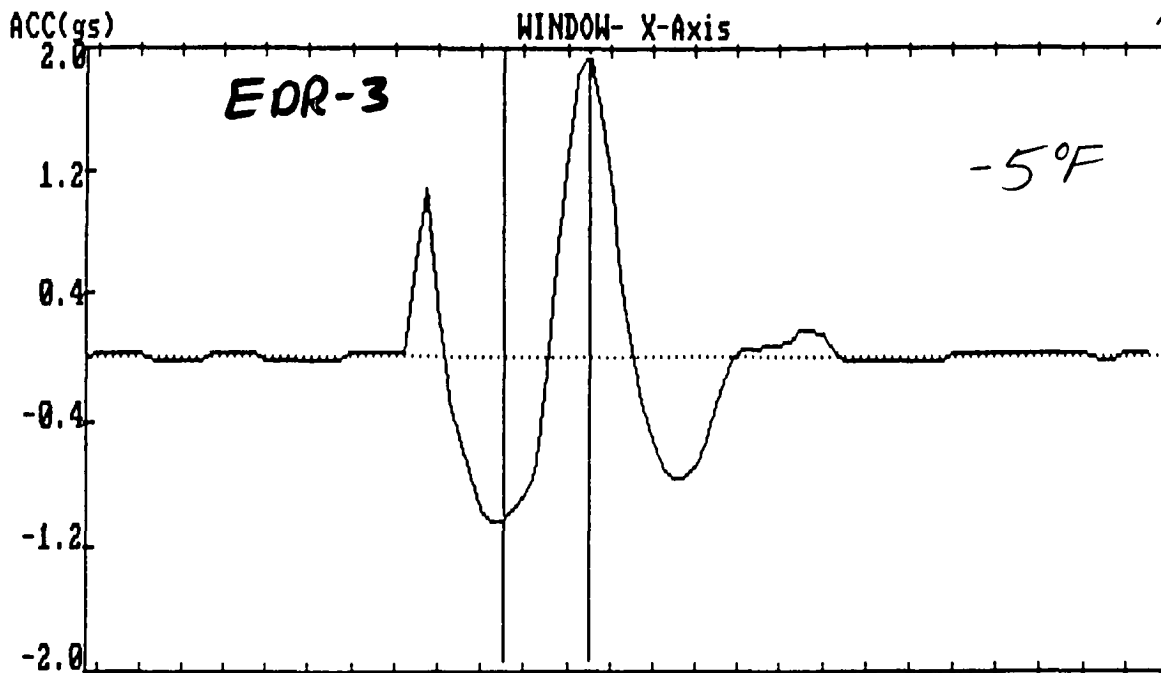


Input = 2.0g

Unit 4  
Event 16



Unit 4  
Event 18



14:06:11

file  
TS3m24

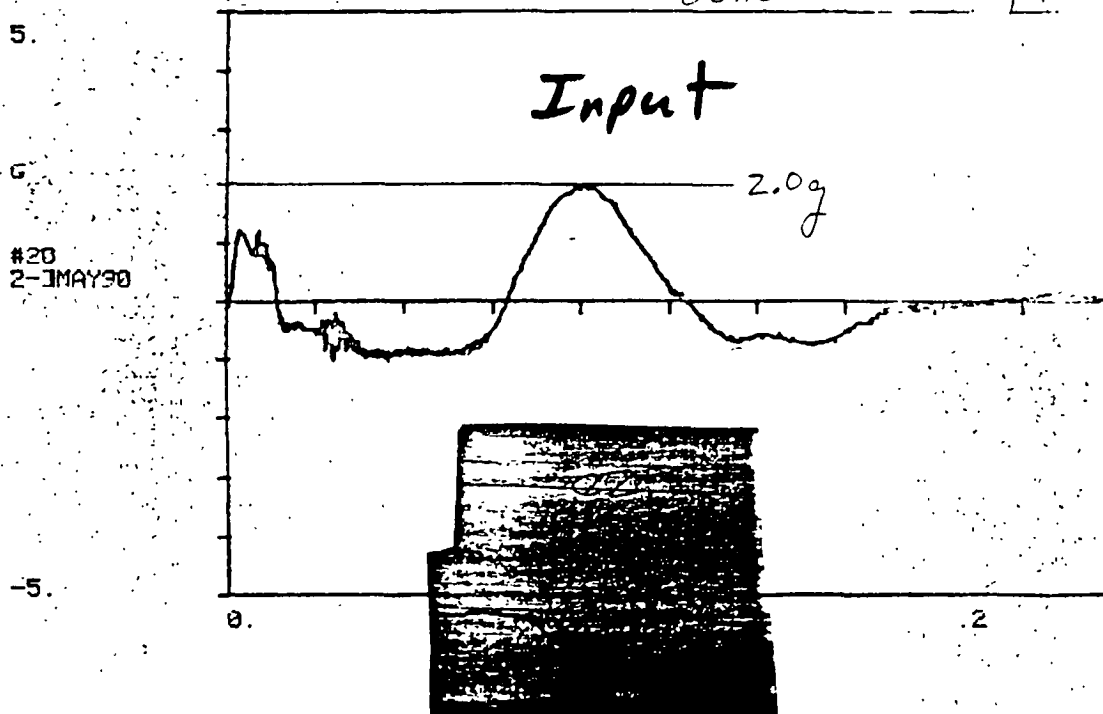
L-P1: 40 A1: -1.04Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 1.96Gs Delta-VEL: 8.6 in/sec sz 1

Input 2.0g

-4°F

14:06:10

2 May 90



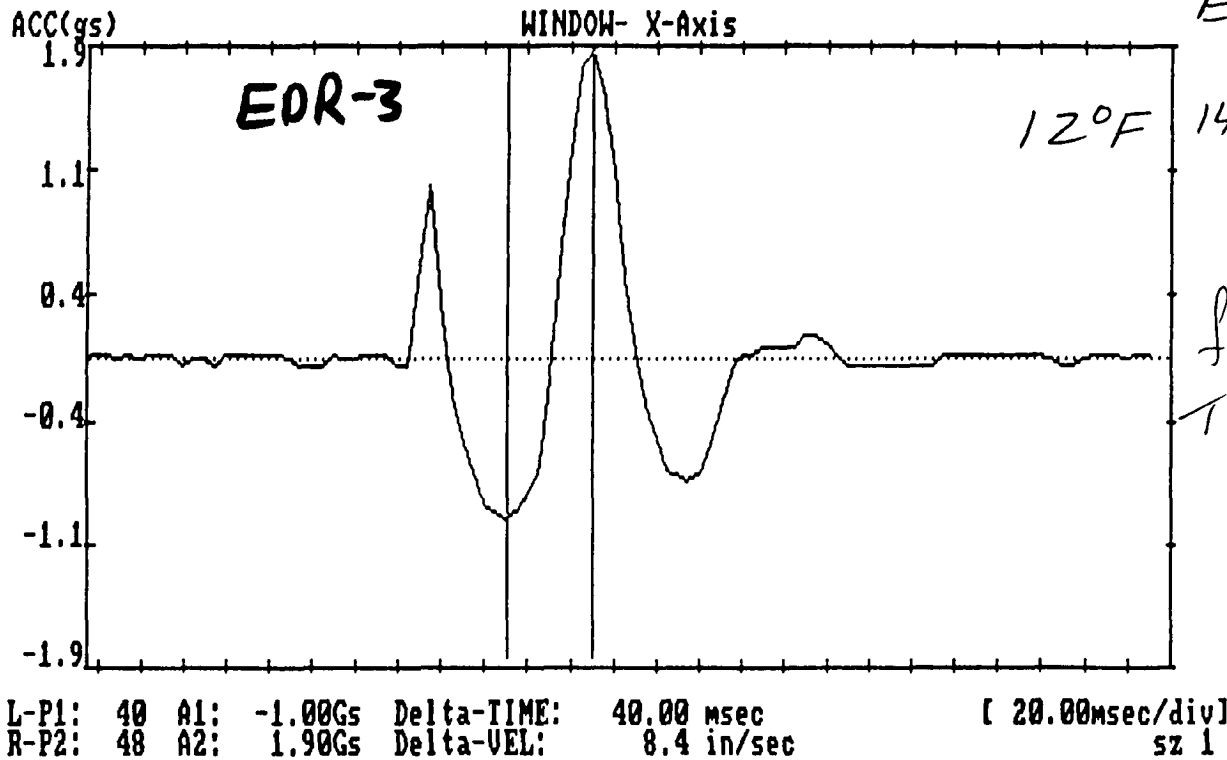
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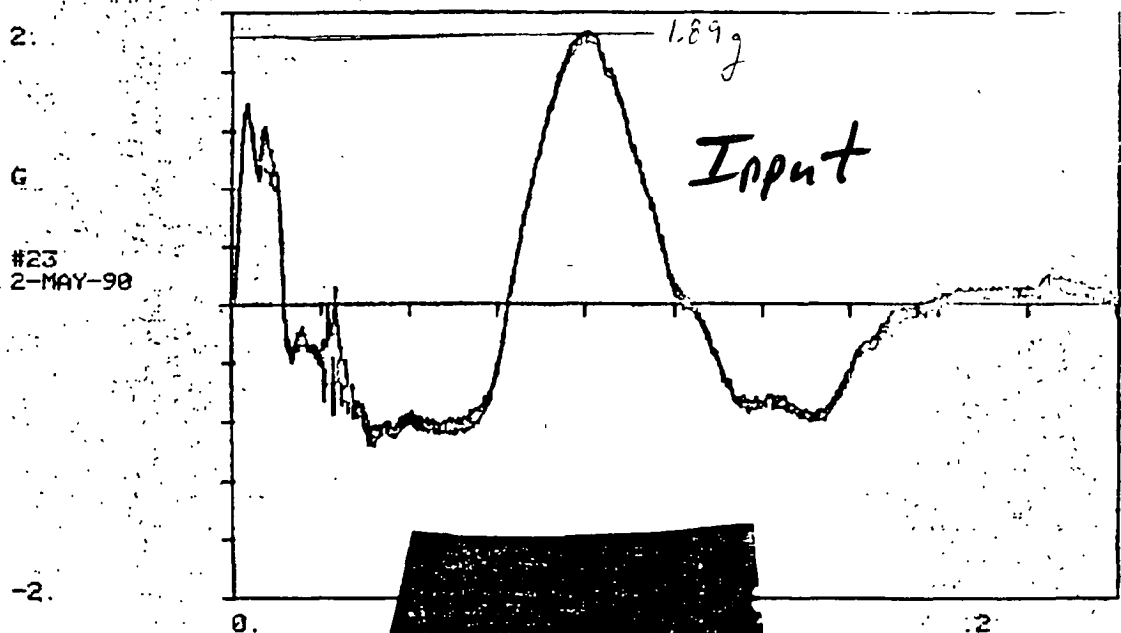
Unit 4  
Event 21



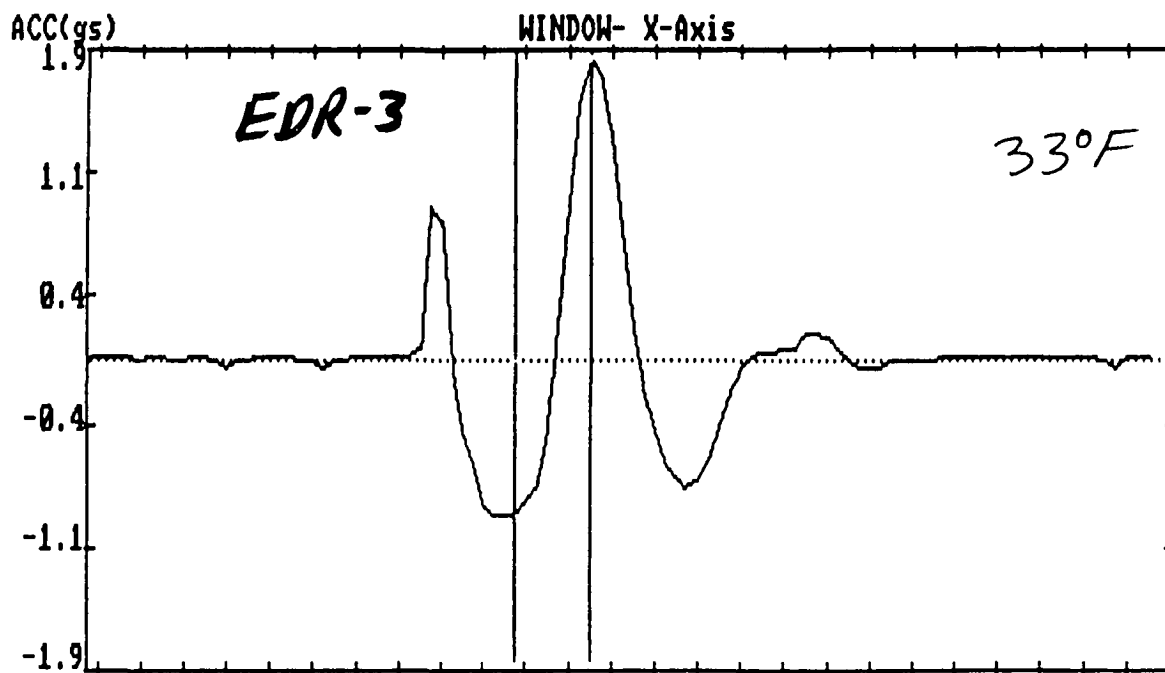
Input 1.89g

14:23:41

2 May 90



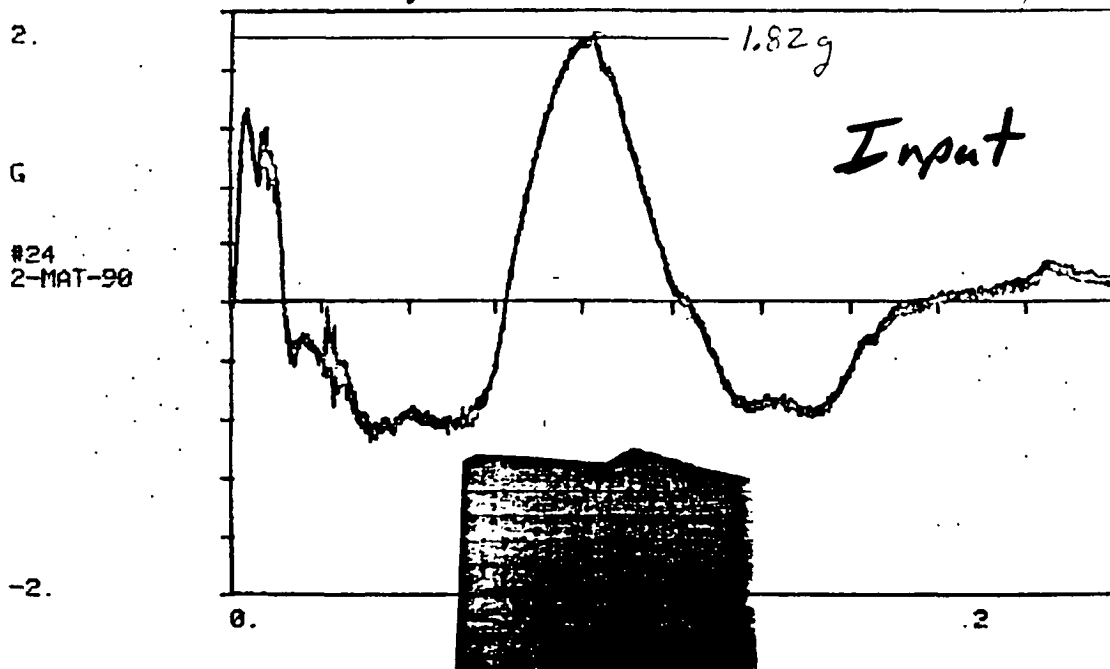
Unit 4  
Event 22



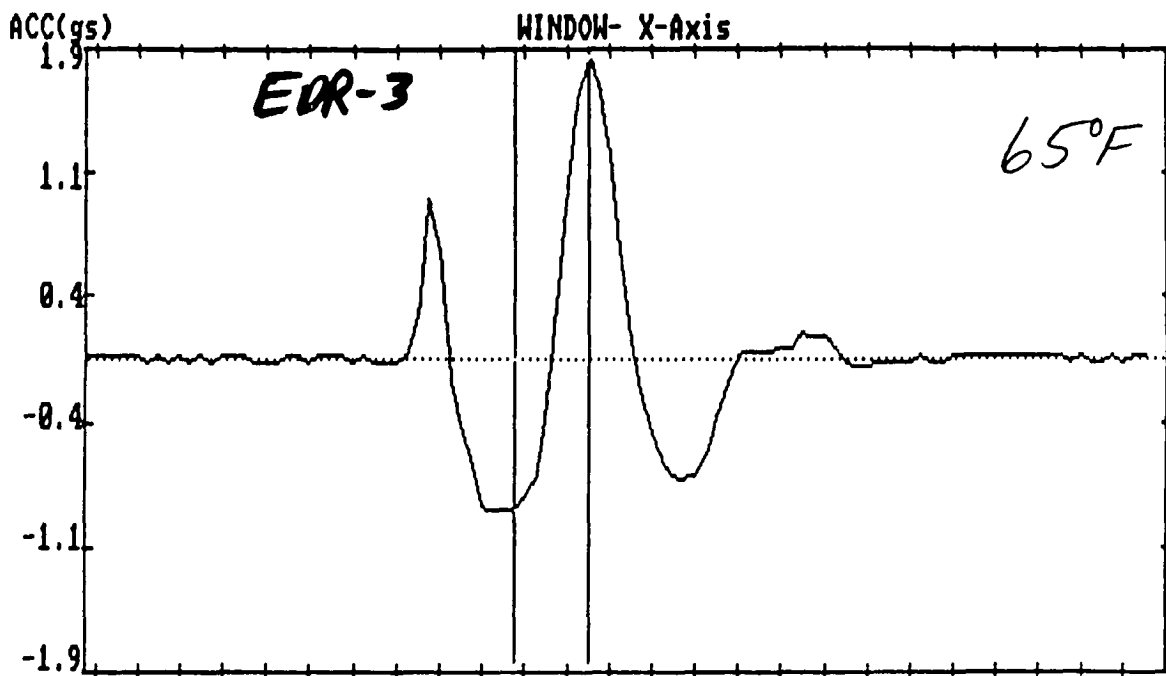
L-P1: 41 A1: -0.96Gs Delta-TIME: 35.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 1.88Gs Delta-VEL: 7.7 in/sec sz 1

Input 1.82g

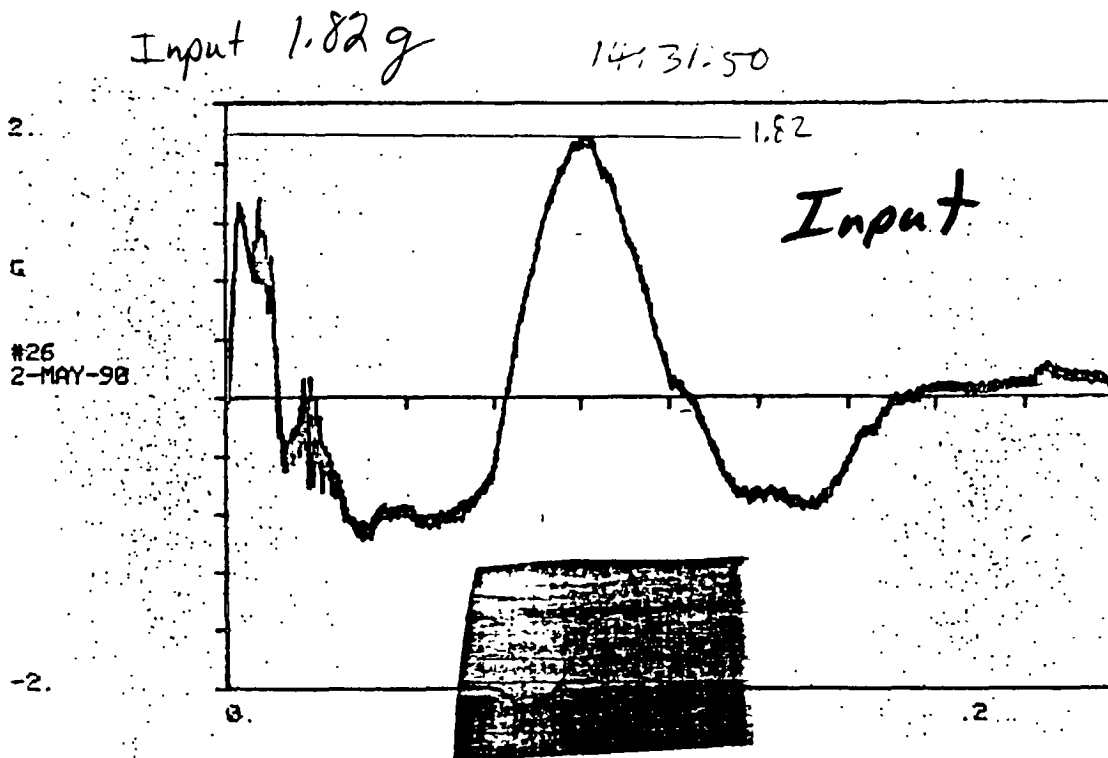
14:26:29 2 May 90



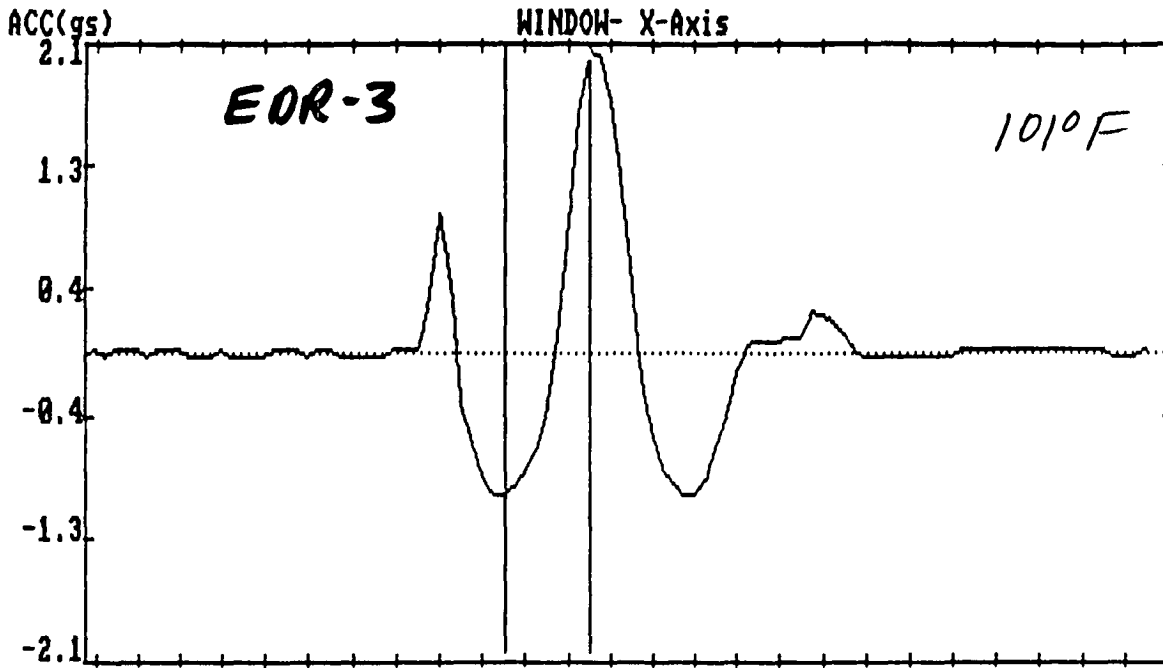
Unit 4  
Event 24



L-P1: 41 A1: -0.94Gs Delta-TIME: 35.00 msec [ 20.00msec/div] sz 1  
R-P2: 48 A2: 1.88Gs Delta-VEL: 8.6 in/sec



Unit 4  
Event 26

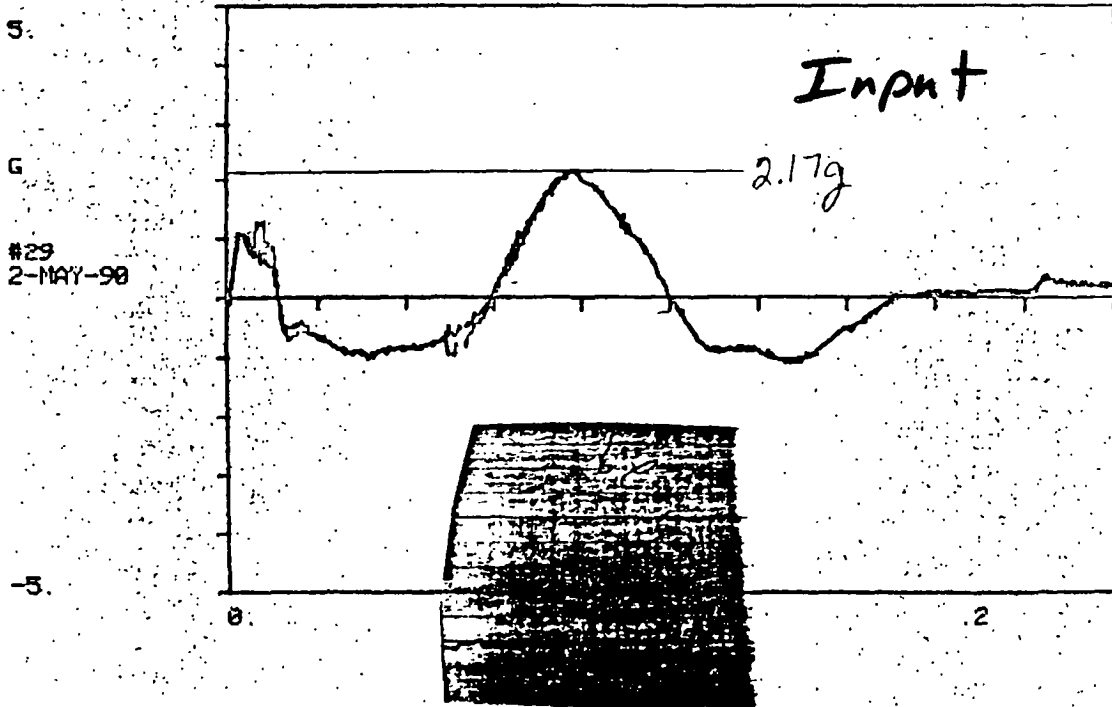


L-P1: 40 A1: -1.00Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 2.14Gs Delta-VEL: 7.0 in/sec sz 1

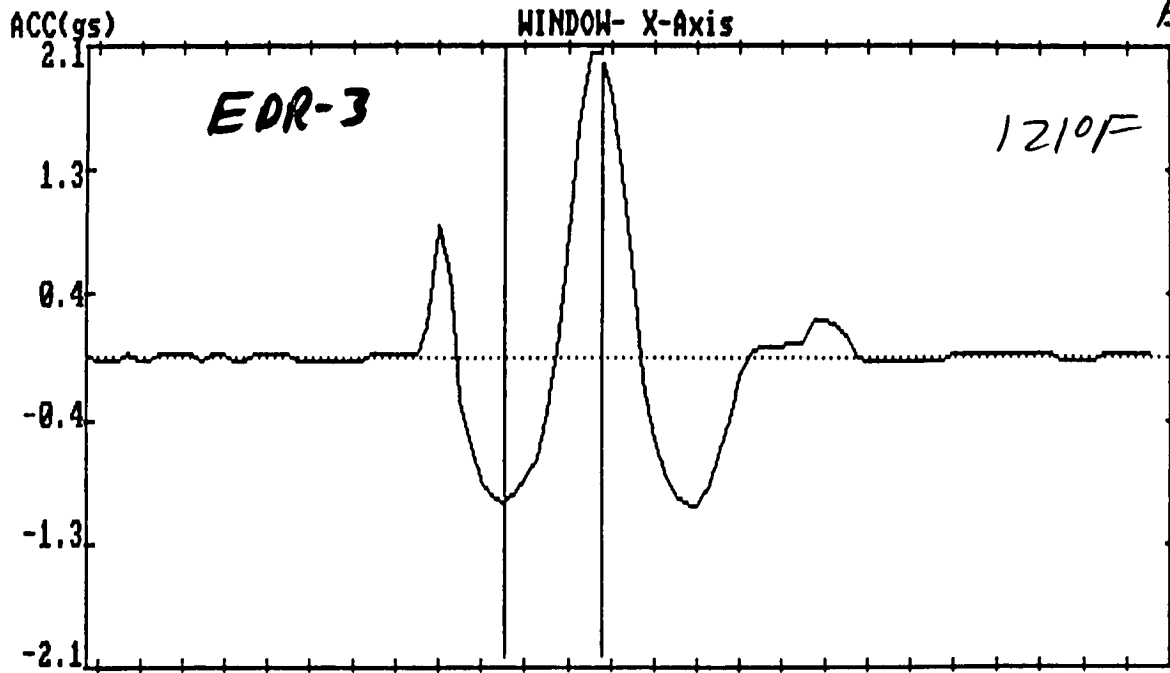
Input 2.17g

14:47:26  
476

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Unit 4  
Event 28



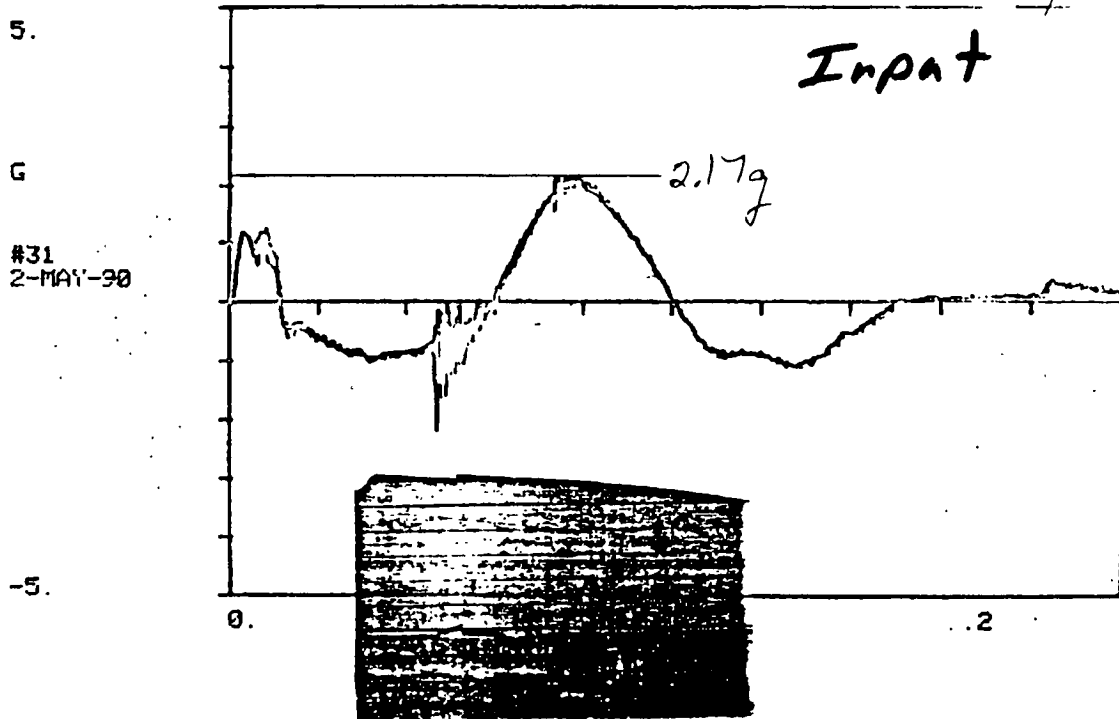
15:09:11

file  
T53m24

L-P1: 40 A1: -1.02Gs Delta-TIME: 45.00 msec [ 20.00msec/div]  
R-P2: 49 A2: 2.12Gs Delta-VEL: 10.5 in/sec sz 1

Input 1.17g

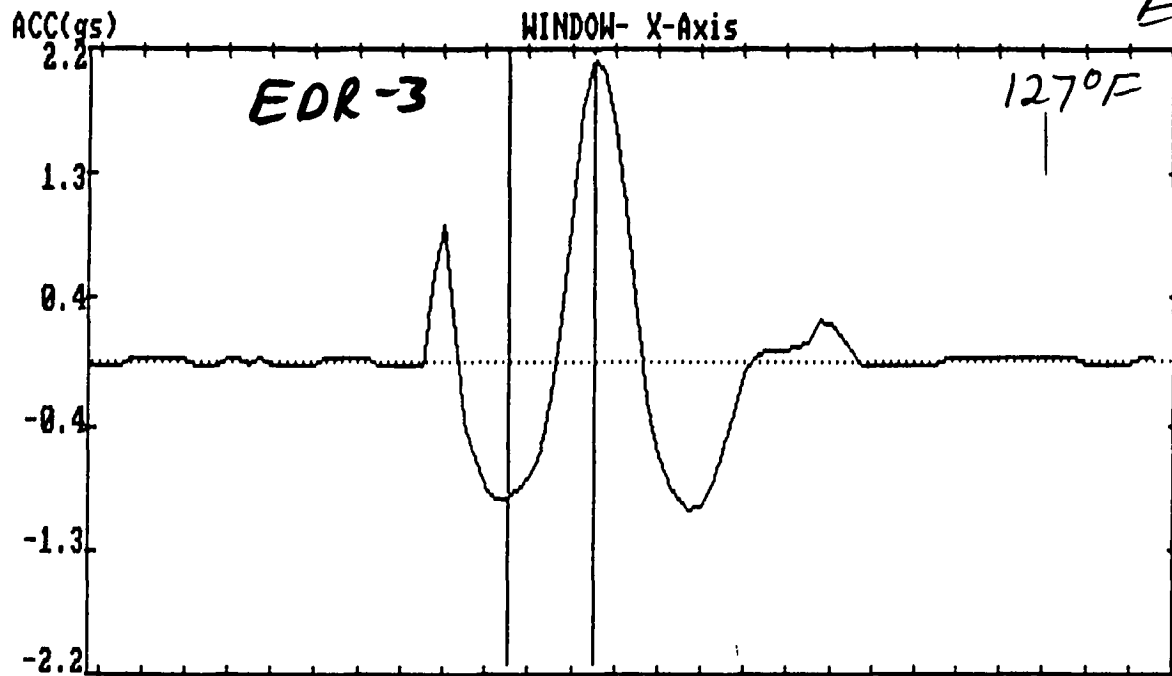
116°F  
15:09:10  
2 May 90



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Unit 4  
Event 30



15:28:26

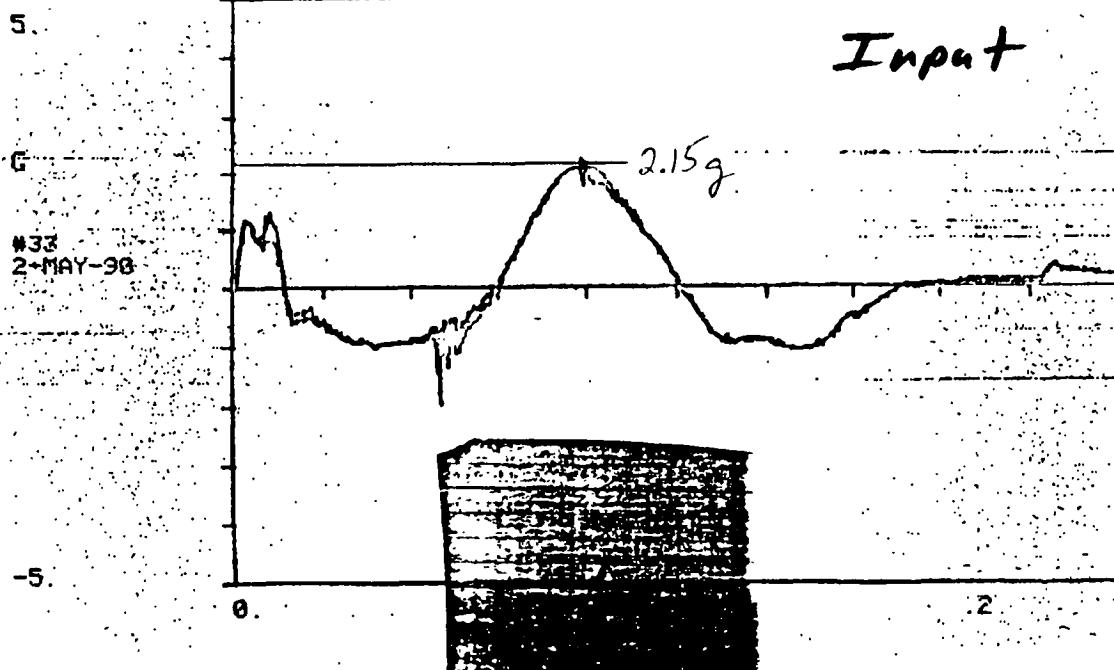
file  
153m24

L-P1: 40 A1: -0.98Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 2.18Gs Delta-VEL: 8.4 in/sec sz 1

Input 2.15g

125°F 21 May 90

15:28:26



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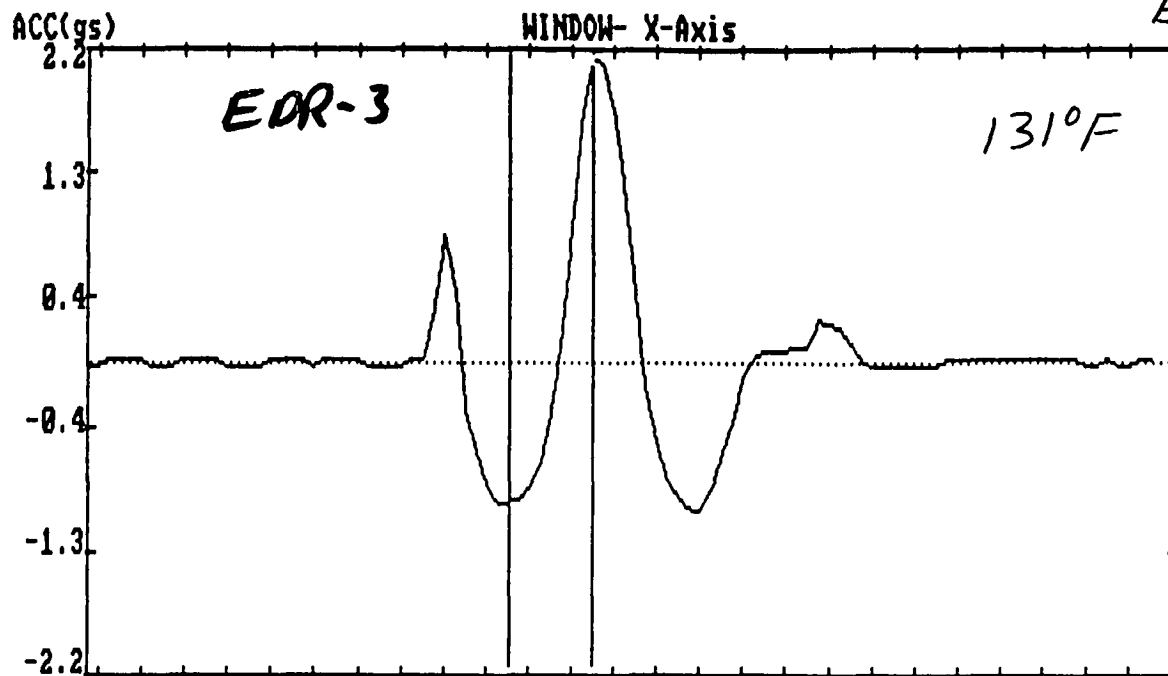
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Unit 4  
Event 31



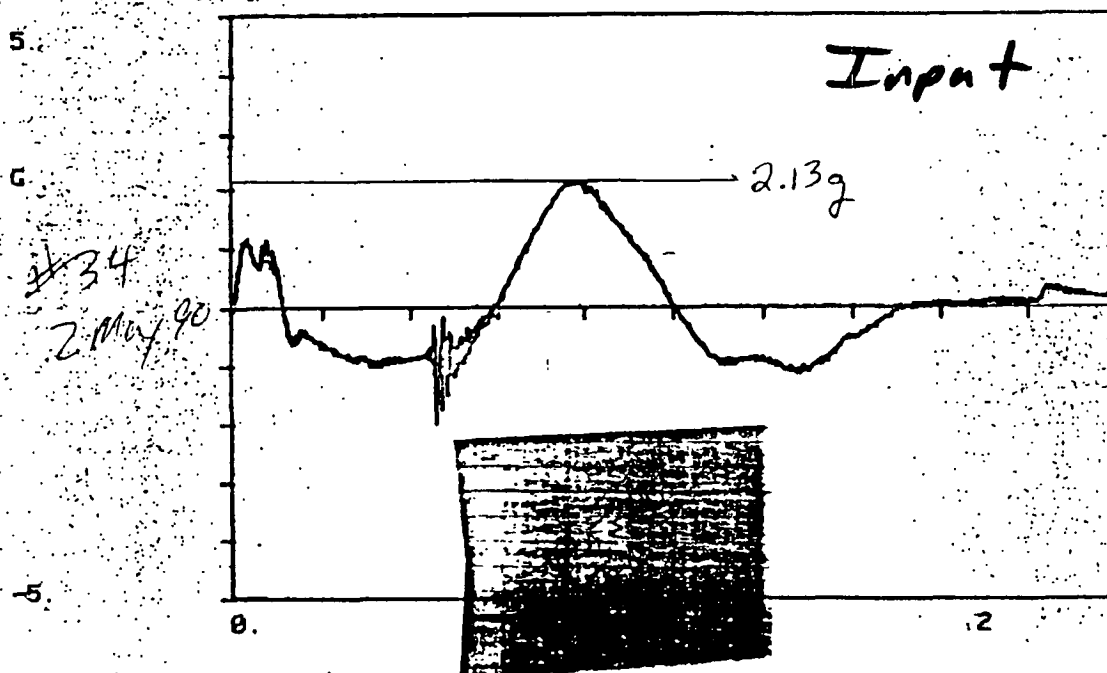
L-P1: 40 A1: -1.00Gs Delta-TIME: 40.00 msec [ 20.00msec/div] sz 1  
R-P2: 48 A2: 2.18Gs Delta-VEL: 7.0 in/sec

Input 2.13g

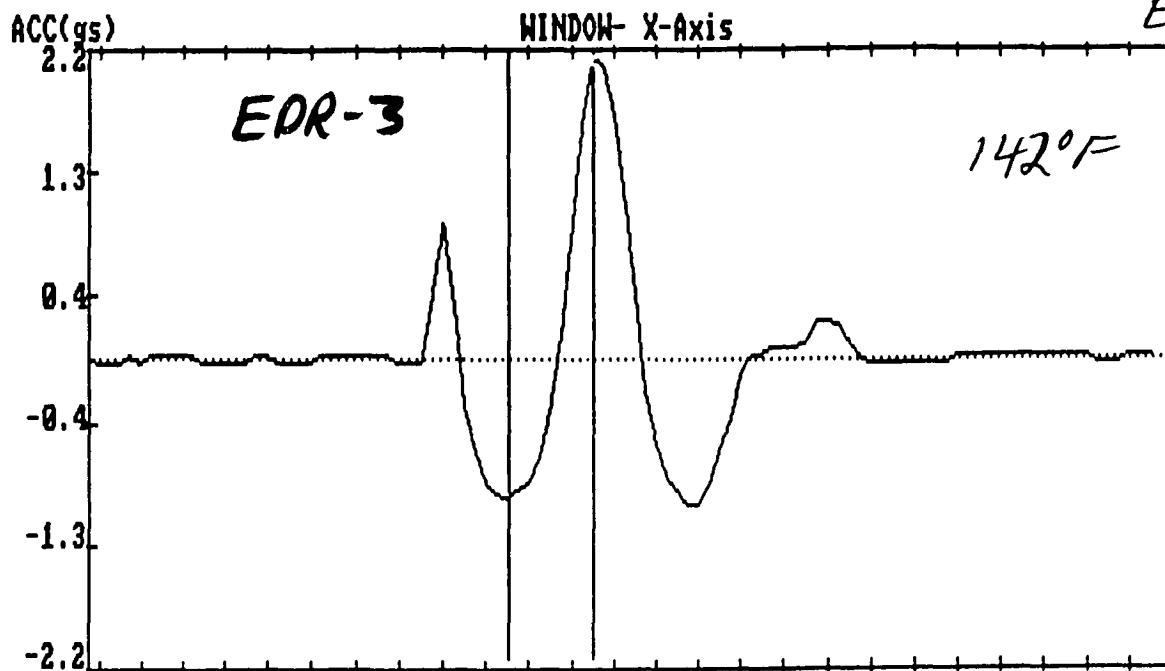
131°F

15:39:16

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Unit 4  
Event 36



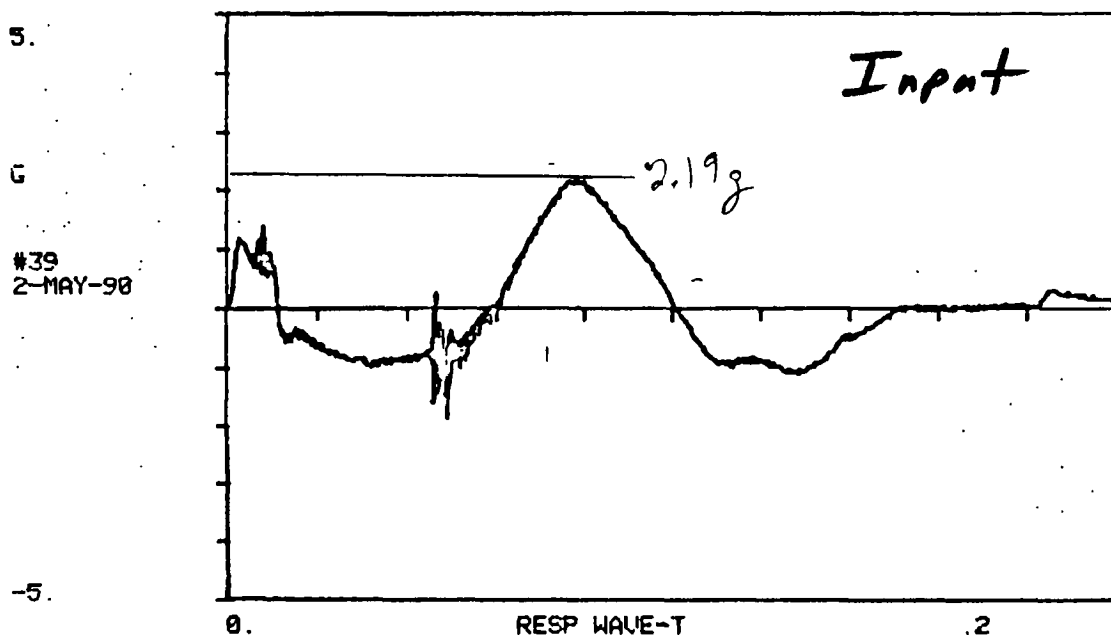
file  
T53m24

L-P1: 40 A1: -1.00Gs Delta-TIME: 40.00 msec [ 20.00msec/div]  
R-P2: 48 A2: 2.18Gs Delta-VEL: 7.4 in/sec sz 1

Input 2.19g

140°F

16:11:06 2 May 90



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